

ENDANGERED SPECIES ACT - SECTION 7

BIOLOGICAL OPINION

UNLISTED SPECIES ANALYSIS, AND SECTION 10 FINDINGS

**for proposed issuance of a Section 10 Incidental Take Permit to the City of Seattle,
Seattle Public Utility, for the Cedar River Watershed
Habitat Conservation Plan**

Agency: National Marine Fisheries Service

Consultation

Conducted By: National Marine Fisheries Service
Northwest Region
Washington State Habitat Branch

Approved:



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Date: April 21, 2000

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I. BACKGROUND

This document constitutes the National Marine Fisheries Service's (NMFS) consultation and Findings in accordance with Sections 7 (a)(2) and 10 (a)(2)(B) of the Endangered Species Act of 1973 (ESA), on the issuance of an Incidental Take Permit (ITP) and unlisted species agreement to the City of Seattle's Public Utility (City) based upon their Habitat Conservation Plan (HCP) and Implementation Agreement (IA).

Only one of the anadromous salmonids that are addressed in the HCP is now listed for protection under the ESA - Puget Sound (PS) chinook salmon. For the four other species of anadromous fish which are currently unlisted, and thus not protected under the ESA nor subject to the provisions of Sections 7 and 10, the NMFS has agreed pursuant to the unlisted species provisions of the IA, to add a species to the ITP when and if any of these anadromous species become listed in the future. As well as being a Biological Opinion for the proposed action of issuing an ITP for PS chinook, this document also provides the rationale and biological basis for making the decision whether to add the four unlisted species, within the administrative requirements of Sections 7 and 10, and subject to a subsequent determination by NMFS according to the IA (section 12.2). Note that all of the anadromous fish were addressed during development of HCP conservation measures as if they were already ESA protected.

Based on this HCP, the U.S. Fish and Wildlife Service (FWS) is deciding whether to issue a Section 10 (a)(1)(B) incidental take permit to the City for the northern spotted owl, marbled murrelet, bald eagle, peregrine falcon, gray wolf, and grizzly bear. Similar to this analysis, the FWS has completed a parallel Biological Opinion of the effects of this HCP on the fish and wildlife species under their jurisdiction, including an analysis of 6 listed and 71 currently unlisted species that are addressed in the HCP (USF&WS, 2000).

Over the last several years, the FWS and the NMFS (together the Services) provided technical assistance to the City during the HCP development and cooperated with the City in the preparation of an Environmental Assessment (EA) to satisfy environmental review under the National Environmental Policy Act (NEPA) (1969).

In December of 1998, the Services received an initial application package from the City. The distribution to interested parties was begun and Federal Register notices were published on December 11, 1998, and January 5, 1999 (63 FR 68469, and 64 FR 480), which announced the release of the draft HCP and IA, permit application and draft EA to the public. The comment period which closed on February 11, 1999, was extended to March 1, 1999, at the request of several commenters (City et al., 1999b).

The Services and the City prepared a Final NEPA EA/SEPA EIS on the HCP (City et al., 1999a) and

a 767 page Response to Public Comments on the Public Review Draft of the EA/EIS (City et al., 1999b). These two documents were made available to the public on May 27, 1999. The Services attempted to address public, tribal and agency concerns raised about the HCP and discussed alternative approaches with the City. The City worked with the Mayor, who in turn recommended HCP changes to the Seattle City Council which approved the changes on July 12, 1999 (City of Seattle 1999). Further changes were approved by the council on December 6, 1999, and are fully described in revised documents supplied to the Services on January 6, 2000. This BO and Unlisted Species Analysis is based on the latest amended HCP from the City of Seattle, which includes HCP changes documented in City Council Resolutions and exhibits (City of Seattle, July 12, 1999, and December 6, 1999). As well, this analysis is based on information provided in the HCP, the EA, technical papers prepared to support the HCP, and various other documents cited later in this document and listed in the References Section. A complete administrative record on this analysis is on file in the National Marine Fisheries Service's Washington State Habitat Branch Office in Lacey, WA.

Initiation of consultation is considered to have begun on the day that the Seattle City Council voted on the changes to the proposed HCP and the revised set of HCP conservation measures was made known to the NMFS and the FWS, i.e., July 12, 1999.

II. PROPOSED ACTION - PROJECT DESCRIPTION

The City has applied to both the NMFS and FWS for an ITP under Section 10(a)(1)(B) of the ESA for City operations (HCP covered activities) in the Cedar River watershed, e.g., improved fish access, instream flows, operation of a sockeye mitigation hatchery, road management, construction of a education center, and research into wildlife, fisheries, and watershed that may occur on City lands during the 50 year term of the HCP and ITP. No commercial logging is proposed in the final HCP. The HCP provides mitigation for the incidental take of seven federally listed species, including the PS chinook. This mitigation includes providing instream flows located mostly below City lands, and increased access to Cedar River habitat on City lands for all the anadromous fish. The proposed HCP would also conserve habitat for a multitude of unlisted species on City lands in the Cedar River Watershed. As a result, the proposed Implementation Agreement (IA), which specifies the terms, conditions, resources, and expectations of the parties to the agreement will cover both listed and currently unlisted species. Another part of the proposed action would be for NMFS to sign the related agreements that are components of the HCP, for instream flows (IFA) and fisheries mitigation (LMA).

A. HCP Plan Area

The subject ownership under the HCP covers City lands comprising approximately 90,546 acres. The majority of the land is well-stocked with conifer trees at stand ages between 30 and 79 years old. All of the watershed is proposed to be managed as an ecological reserve. Most City-managed lands have been logged at least once in the last 100 years.

B. Summary of HCP Actions

The City's final HCP, which is incorporated herein by reference, provides mitigation and minimization measures associated with an ITP for seven federally listed species, including the PS chinook. The HCP also conserves habitat for a multitude of unlisted species in the Cedar River Watershed. The measures described in the HCP include addressing habitat requirements and minimizing, mitigating and monitoring the impacts of covered activities on runs of anadromous salmonids and other species that are candidates for listing by the federal government. The HCP would (1) apply improved watershed management, including a riparian conservation strategy to the Cedar River lands; (2) provide instream flows in the Cedar River, located mostly below City lands, for resident and anadromous salmonids; and (3) provide fisheries mitigation for the existing water diversion structure at Landsburg.

Specific agreements have been negotiated by the City with federal and state agencies that address instream flows (i.e., the Instream Flow Agreement or IFA) and anadromous fish (i.e., Landsburg Mitigation Agreement or LMA). These are attachments to the HCP but have also been developed to be stand-alone agreements with state agencies that could be de-linked from the federal HCP process. The HCP, IFA, and LMA strategies propose to maintain or restore salmonid habitat and to contribute to the conservation of other riparian and riparian-obligate species. These strategies are fully described in Chapter 4 of the HCP (City, 1998), technical appendices to the HCP, and subsequent amendments described in related documents from the City of Seattle (1999, 2000).

As described in the LMA, the City is providing the funding and framework for resource agencies to collaboratively make adaptive management decisions about the conservation of the five anadromous fish species (LMA, Appendix 28 to the HCP).

C. Covered Activities

Covered activities are described in the HCP and IA, and in summary are: all City operations on the Cedar River in conjunction with its water supply (including instream flows), hydroelectric power generation, and land management activities, including attendant facilities. Covered municipal watershed management activities include thinning, reforestation, and mechanical brush control; repair, re-engineering, decommissioning, and maintenance of forest roads, including use of gravel pits and other rock sources, as well as maintenance and replacement of culverts and bridges. Other covered watershed activities include actions to protect and restore watershed

habitats, both aquatic and upland; the sockeye supplementation program; cultural resource management and educational programs within the municipal watershed, including a public tour and field trip program and construction of educational and cultural facilities; scientific research, both by City staff and outside scientists; and other activities or facilities identified elsewhere in the HCP. The application of the term Covered activities® as it applies to the waters downstream of Landsburg is restricted specifically to the impacts of City operations and facilities on species using those waters and covered by this HCP, and does not apply to the impacts of activities by other public agencies or private parties. In general, covered activities downstream of Landsburg include mitigation, conservation, research, and monitoring activities carried out under the HCP and the related agreements (IFA and LMA, HCP Appendices 27 and 28, respectively).

D. Action Area

The action area for this Biological Opinion, by regulation (50 C.F.R. ' 402.02) includes all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action.® In this case, the proposed federal action is issuing the ITP. Indirect effects include potential impacts of the sockeye supplementation program upon salmonid populations throughout Lake Washington. Also, potential instream flow effects in the Cedar River could extend, with diminishing magnitude, from the new compliance point (River Mile 20.4) downstream to the mouth of the river at Lake Washington. Therefore, the action area includes the entire mainstem Cedar River and Lake Washington, and the Sammamish River, including Bear Creek.

It is difficult to describe the potential for indirect effects of the proposed HCP, including the related Cedar River instream flows, that could act upon one of the five anadromous fish species and that extend beyond the mouth of the Cedar River and that can be analyzed at this time. See the section VI (D) below for detailed analyses.

The Army Corps of Engineers (ACOE) is responsible to consult with NMFS for possible ESA effects on the issuance of section 404 permits under the Clean Water Act for any habitat restoration measures funded by the City on non-HCP lands in the Lake Washington basin, that may affect listed species as part of proposed actions that involve wetlands or waterways (detailed in HCP section 4.3.2). Therefore, ESA effects of those proposed actions will be addressed by those future, separate section 7 consultations.

E. Changed and Unforeseen Circumstances

Under the HCP, the City could be required to provide additional mitigation in response to the changed circumstances identified in the HCP (Section 4.5.7). These circumstances apply for six types of environmental events: forest fires, windstorms, insect infestations and disease outbreaks,

floods, landslides, and droughts. The HCP states thresholds of each event that would trigger changed and unforeseen circumstances.

In the event of changed circumstances related to environmental events, the City will consult with the Services regarding implementation of the contingency plans described in the HCP and in the example below, including whether alteration of mitigation, within the scope of the HCP, might be warranted. If the City and Services agree that alteration of mitigation is needed, then the City and Services will agree upon any changes to the mitigation described in the HCP. After such agreement, the City will implement the changes to mitigation on a schedule agreed upon by the parties.

For example, **changed circumstances for windstorms** are defined as events that result in (1) complete blowdown of 200 - 500 ft of riparian buffer along any fish-bearing stream; or (2) complete blowdown along any stream from which substantial amounts of sediment could be delivered downstream as a result of the blowdown that would result in significant adverse impacts to reaches equal to 200 - 500 ft of a fish-bearing stream.

- **Unforeseen circumstances for windstorms** are defined as events that result in (1) complete blowdown of more than 500 ft of riparian buffer along any fish-bearing stream; or (2) complete blowdown along any stream from which substantial amounts of sediment could be delivered downstream as a result of the blowdown that would result in significant adverse impacts to reaches equal to more than 500 ft of a fish-bearing stream.
- **The contingency plan for windstorms** under changed circumstances includes the following:

Measures to reduce sedimentation, including measures to stabilize slopes, if feasible, by reprioritizing use of funds for riparian and/or stream restoration activities in the HCP; and,

Measures to restore riparian forest, including such measures as replanting trees by reprioritizing HCP funds for riparian restoration or other restoration activities.

1. Adaptive Management for Studies or Monitoring under Changed Circumstances

The three issues listed below, and the contingent responses to potential outcomes, are discussed in the sections of the HCP that are cited for each. Each of these issues is defined as changed circumstances for the HCP. All three issues entail monitoring or other studies related to outcomes about which there is substantial uncertainty. In each case, there is a commitment to adjusting measures in the HCP based on the results of the studies or monitoring.

a. Accretion Flows. The study of accretion flows downstream of Landsburg, with

limited potential adjustment in instream flows based on results (sections 4.4.2 and 4.5.2), as provided for in the IFA (Appendix 27).

b. Landsburg Fish Passage. Contingent mitigation if, based on monitoring results, the City must curtail passage of chinook and/or coho salmon over the Landsburg Dam for water quality reasons, including regulatory changes (sections 4.3.2 and 4.5.3), as provided for in the LMA (Appendix 28).

c. Sockeye Hatchery Operation and Effectiveness. Monitoring and operation of the sockeye hatchery needed to control undesired impacts on wild fish and to determine effectiveness in helping to meet long-term goals for harvestable runs (sections 4.3 and 4.5.3), with provisions for altering hatchery operations or developing alternative mitigation, as provided for in the LMA (Appendix 28).

The sections cited for each of the three issues described above specify the type and extent of additional or alternative mitigation that would occur under changed circumstances, describe a process for determining that alternative or additional mitigation, or do both. For each of the three specific applications of adaptive management described above, the City will develop and present in a document, as provided for in the IA, the following elements and criteria:

- A general monitoring and/or research plan based on explicit hypotheses, the biological objectives described in this HCP, and the appropriate research and/or monitoring plans described in the HCP Section 4.5;
- Threshold criteria for triggering additional or changed mitigation;
- Limits to the type of and commitments to any long-term mitigation triggered by monitoring criteria;
- A procedure for dispute resolution over interpretation of results consistent with dispute resolution procedures specific to the relevant agreement; and
- A process for developing and implementing any additional mitigation for which the need is demonstrated and that clearly identifies the responsibilities of the parties involved.
- The schedule for preparing the Adaptive Management Plans varies by issue: for Accretion Flows by the end of HCP year 3; for Landsburg Fish Passage, one year prior to initiation of adult fish passage above the dam; and for the sockeye hatchery, one year prior to initial operation of the replacement hatchery.

III. SPECIES STATUS OF ANADROMOUS FISH SPECIES COVERED UNDER THE HCP

A. ESA Status of the Anadromous Fish Species

ESA determinations for all five species have been made by NMFS, based on published information developed by NMFS= Biological Review Teams (NMFS status reviews, 1995, 1996, 1997, 1998a, 1999). The PS chinook were listed as threatened on March 24, 1999 (64 FR 14308). PS coho were determined to not warrant proposed listing on July 25, 1995 (60 FR 38011). PS steelhead were also determined to not warrant proposed listing on August 9, 1996 (61 FR 41541). Coastal cutthroat were determined by NMFS to not warrant a proposed listing on April 5, 1999 (64 FR 16397). A status review of sockeye in the Cedar River by NMFS found that this stock was introduced from outside Lake Washington and was therefore not included in a recognized ESU (63 FR 11761, March 10, 1998).

The City has addressed PS chinook salmon (*Oncorhynchus tshawytscha*), coho salmon (*O. kisutch*), steelhead trout (*O. mykiss*), sockeye salmon (*O. nerka*), and coastal cutthroat trout (*O. clarki*) within the HCP. Salmonid stocks in the Cedar River have been described in a recent stock assessment by the Washington Departments of Fish and Wildlife and Western Washington Treaty Indian Tribes, which did not include coastal cutthroat trout, (WDF et al. 1993). For the three stocks for which a status could be determined (WDF et al. 1993), sockeye and steelhead were Adepressed @ and coho was rated as Ahealthy.@ Note that the Muckleshoot Indian Tribe (MIT) fisheries managers now consider the coho to be depressed (P. Haage, MIT, pers. com., 1999). Detailed information of the biology and stock status of individual species can be found in Section 3.5 of the HCP and Section 3.4 of the EA.

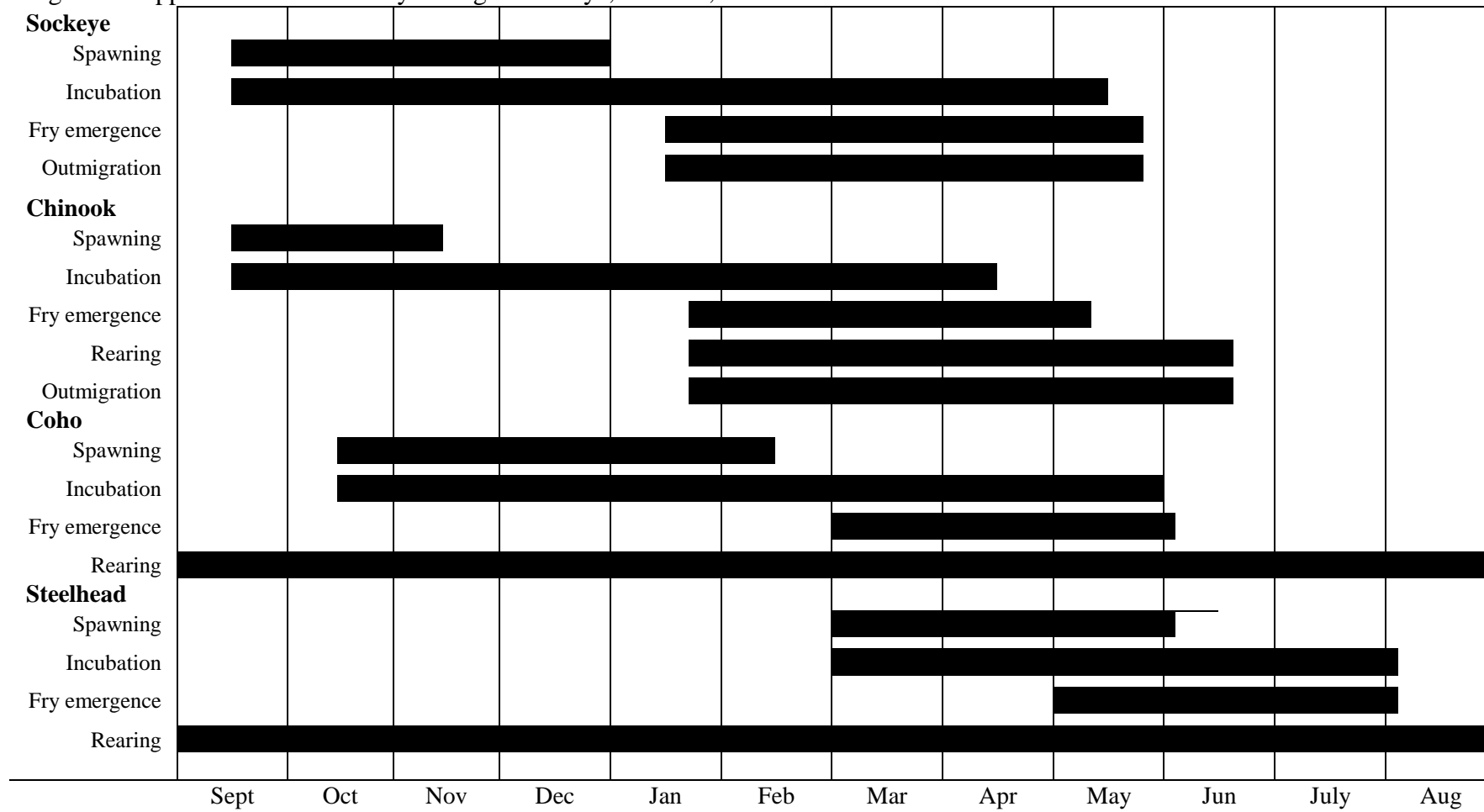
The portion of the Cedar River watershed owned by the City of Seattle, referred to as the Cedar River Municipal Watershed, is currently inhabited by non-anadromous salmonids. Manmade barriers to upstream adult fish passage are located at the water pipeline crossing at RM 21.4 and the Landsburg water diversion dam at RM 21.8. Rainbow trout and cutthroat trout occur in the Cedar River and most tributaries between the Landsburg Dam and Masonry Dam (RM 36), with rainbow trout predominant in the mainstem Cedar River and cutthroat in the smaller streams. Upstream of the Masonry Dam, the upper municipal watershed includes stream resident populations of rainbow trout as well as adfluvial forms of bull trout (*Salvelinus confluentus*) and pygmy whitefish (*Prosopium coulteri*) that migrate from Chester Morse Lake to spawn in tributary rivers and streams. No cutthroat trout are reported to occur in the Municipal Watershed upstream of Masonry Dam.

The status and life history strategies of salmonids in the Cedar River are described in detail within the HCP (City 1998). Populations of PS chinook or other anadromous salmonids in the

Cedar River have not yet been evaluated by NMFS to assess the contribution to the entire ESU. An outline of a way to assess population status within the context of determining Viable Salmonid Populations is described in a recently proposed rule (65 FR 170, January 3, 2000). This step of identifying populations that may warrant individual management could be developed by the Cedar River Anadromous Fish Committee (CRAFC) as part of HCP implementation

Following are summaries taken from the WDF (1975), WDF et al. (1993), the NMFS status reviews (NMFS 1995, 1996, 1997, 1998, and 1999), the EA, the HCP, and related documents.

Figure 1. Approximate Life history timing of sockeye, chinook, and coho salmon and steelhead trout in the Cedar River



B. Puget Sound Chinook Salmon

The chinook salmon is the largest of the seven species of Pacific salmon. Mature adults can reach ages of five to seven years and weights in excess of 40 kilograms (kg). Chinook are the least numerous of the five Pacific salmon species that occur in North America. In the eastern Pacific, spawning populations range from the central coast of California, north to the drainages of Kotzebue Sound (NMFS 1998).

According to WDF et al. (1993), there are 26 stocks of chinook salmon in Puget Sound. At the time of their report, the authors classified the population status of approximately half of the stocks as depressed. However, since that time, there has been a sharp decline in the abundance of Puget Sound chinook, and nearly all naturally reproducing populations in the area are now considered depressed (NMFS 1998). Although the Cedar chinook were considered to be of undetermined status in 1992, the MIT fisheries managers consider the Green River stocks to be a useful surrogate for the Cedar, and those stocks are recently showing trends of decreasing harvest and increasing escapement to the spawning areas (P. Haage, MIT, pers. com., 1999).

1. Stock Origin and Current Status

Cedar chinook are considered to be genetically original stock (P. Haage, MIT, pers. com., 1999). The Lake Washington watershed has a long history of being stocked with hatchery reared salmonids (Ajwani, 1956, cited in the HCP). Today, the majority of chinook salmon returning to the basin originate from the Issaquah and University of Washington hatcheries. Hatchery-reared chinook were planted in the Lake Washington basin as early as 1914 (Darwin, 1916, cited in the HCP). Ajwani (1956, cited in the HCP) reported extensive plantings of Issaquah and Green River hatchery chinook into Cedar River during the period from 1943 to 1954. According to a 1948 WDF report, salmon returns to the Cedar River were at one time negligible, but were significantly enhanced by plantings from the Issaquah and Green River hatcheries (WDF, 1948, cited in the HCP). Like many early artificial production programs, the effectiveness of this planting program was not rigorously monitored. Therefore, it is difficult to confirm the former status of salmon in the Cedar River. Currently, there are no releases of hatchery chinook into the Cedar River.

The recent stock assessment WDF et al. (1993) classified the status of Lake Washington chinook salmon as unresolved due to differing viewpoints of state and tribal resource managers. Johnson et al. (1997, cited in the HCP) describe wild PS chinook as relatively stable from 1968 to 1990 with a sharp drop in abundance after that time.

2. Life History Overview

Like all eastern Pacific salmon, chinook are anadromous, i.e., they return to their natal streams to spawn, and they are semelparous (die after spawning). In an extensive review of the literature, Healey (1991) used differences in life history patterns to divide eastern Pacific chinook salmon into two broad races: stream-type populations and ocean-type populations. While there is substantial variation in specific life history patterns between and within stocks in each race, it is possible to discern broad, general patterns unique to each race. In North America, spawning populations of stream-type chinook are predominant north of latitude 56°N and in headwater areas of large river systems throughout the species-range. Ocean-type populations predominate south of latitude 56°N, except in headwater areas of large river systems. Table 3.4-1 of the HCP summarizes the key life history attributes of each race. Note that stocks in the extreme south and north of the chinook-range may depart somewhat from this general model (Kjelson et al., 1982; Hallock and Fry, 1967; Yancey and Thorsteinson, 1963; all cited in the HCP).

Cedar River chinook appear to be relatively well-matched with the description for ocean-type chinook. Their natal stream is located well south of 56° N, but is still within the central portion of the range of eastern Pacific chinook populations. Adult chinook enter Lake Washington through the Ballard Locks from late June through September with a peak in late August (Warner, 1998, cited in the HCP).

3. Spawning

Chinook spawning behavior is similar to that of other salmonids. The female selects an appropriate spawning location over gravel and small cobble substrate where she excavates the redd. Chinook salmon enter the Cedar River from late August and early-September through mid-November, particularly during rain-storms that swell the river (CES, 1991). Chinook spawn soon after entry into the river with the peak spawning period usually occurring in early to mid-October. Spawning occurs in the mainstem of the Cedar River downstream of Landsburg and above RM 1.3, with limited use of the larger tributary streams below the Diversion Dam (HCP, section 3.5)

4. Incubation and Early Rearing

Chinook eggs in this region typically hatch 2 or 3 months after fertilization. The larval fish, or alevins, remain in the gravel for an additional 2 or 3 months, then emerge into the stream as free-swimming fry. There are little data on the precise development rate and emergence timing of Cedar River chinook. In the lower Cedar River, chinook fry have been trapped as early as mid-January and were collected until the trap was removed in mid-July (D. Seiler, WDFW, pers. com., 1999).

Chinook fry typically emerge at night and tend to exhibit an immediate downstream dispersal (Reimers, 1971; Healey, 1980; Kjelson et al., 1982; all cited in the HCP). Within the ocean-type race, Healey, (1991) distinguishes two life history variations: (1) fry that emerge from the gravel, disperse downstream to the estuary in a matter of hours or days where they then rear for an extended period; and (2) fry that emerge, disperse a shorter distance downstream, then stop and rear in the river for up to 3 months before migrating downstream to the estuary for another period of extended rearing. In several well-studied rivers in southern British Columbia, the movement of newly emerged fry to the estuary typically occurs from early March through early May. A second migration of fry that have reared in the river and are approximately twice the size of the early migrants occurs from mid-May to mid-June (Healey 1991). The degree to which Cedar River chinook exhibit these two alternative behaviors at emergence is not fully known, but preliminary information from recent studies suggests that both patterns are evident in the Cedar River (D. Seiler, WDFW, pers. com., 1999, R. Peters and R. Tabor, FWS, pers. com., 1999). While the distribution and behavior of chinook fry in Lake Washington and the role that the lake plays as a rearing area and migration corridor are not well understood, preliminary interpretation of Lake Washington studies indicates that fry are mostly found along the shoreline from February through early May (K. Fresh, WDFW, pers. com., 1999). And fry apparently disperse to deeper areas after mid-May to June. Note that the City proposes to collect additional chinook-specific information on the Cedar River according to the HCP amendments approved by the Seattle City Council on July 12 and December 6, 1999.

5. Distribution in the Marine Environment

Healey (1991) cites a large number of studies that have reported the importance of estuaries as rearing habitat for ocean-type chinook. The behavior and distribution of juvenile Cedar River chinook, after they have migrated through the Ballard Locks and into salt water, have not yet been studied.

No data are available on the specific distribution of Cedar River chinook in Puget Sound or the North Pacific. However, harvest data for the Green Hatchery stock indicate that nearly all fish that are taken in sport and commercial fisheries are harvested off British Columbia, the coast of Washington, and in Puget Sound. Less than one percent of the fish are harvested off the coast of Alaska (Pacific Salmon Commission, 1996, cited in the HCP). This information suggests that the ocean distribution of Cedar River chinook is likely similar to that described by Healey (1991) for ocean-type populations in this region.

6. Critical Habitat

Presently, of the anadromous salmonids covered by this HCP, only PS chinook are listed under ESA as threatened. Critical habitat was designated in a final rule (65 FR 7764) for PS chinook and includes the marine, estuarine, and freshwater areas of the Lake Washington basin, including the Cedar River below the present limit to anadromous fish passage at the Landsburg diversion dam. Constituent elements of critical habitat for chinook salmon on the Cedar River include the key riparian functions: shade; sediment; nutrient and chemical regulation; streambank stability; and input of organic material, including leaves and large woody material. As well, critical habitat assessed for this Biological Opinion includes Cedar River instream flows and water quality. The analysis of effects to PS chinook (below in section VI) describes how critical habitat constituent elements (e.g. key features of properly functioning riparian and aquatic systems) are addressed by the proposed HCP.

C. Coho Salmon

The coho salmon is one of the most popular sport fishes in the family Salmonidae. For most of the twentieth century it has been the mainstay of the average west coast salmon fishing trip. Coho salmon occur along the Pacific coast from Monterey Bay, California, northward to Point Hope, Alaska (Wydoski and Whitney, 1979). The typical size of adult coho salmon in the Lake Washington basin is between 4 and 7 pounds (WDF 1975).

The population of coho salmon in the Cedar River is defined by the timing of their spawning (late October to late February) as well as their geographic separation from other significant coho streams in the drainage (WDF et al., 1993). It is unknown how spawner interchange or differences in off-station hatchery stocking has influenced the Cedar River sub-population. Until a genetic evaluation is made of the various sub-populations in the basin, designations between Cedar River spawners and other geographical groups are tentative. The status review by NMFS in 1995 included all coho within Puget Sound as one ESU (NMFS 1995).

1. Stock origin and Current Status

The coho population in the Lake Washington watershed is comprised of both natural and hatchery sub-populations. Substantial releases of hatchery yearlings were made from the early 1950s to the early 1970s, and regular fingerling and fry plants were made from the mid-1970s to the present. These releases have included coho salmon from the Minter, Green, and Skykomish rivers. There are also annual yearling releases from the Issaquah Creek Hatchery and the University of Washington (HCP).

Natural spawning populations of coho salmon are common in tributaries to Lake Washington and the Cedar River, including the Lake Walsh sub-basin. The extent of historical and current

mixing between hatchery coho and wild spawning populations, both spatially and temporally, is unknown. As a result of this uncertainty, the two stocks in the Lake Washington basin are designated as mixtures of native and non-native stocks (WDF et al., 1993). According to MIT fisheries managers, the current low numbers of spawning coho in Lake WA (n=200 in 1998-99) include an estimated 12 pair that spawn in the Cedar River (E. Warner, MIT, pers. com., 1999).

2. Life History Overview

Like all eastern Pacific salmon, coho are anadromous and return to their natal streams to spawn. Coho salmon have one of the more predictable life histories of the Pacific salmon. Juveniles spend approximately 18 months in freshwater and go to sea after their second spring. After growing to maturity in the ocean, they return to their natal streams after 18 months.

3. Upstream Migration and Spawning

Adult coho typically begin returning to Lake Washington through the Ballard Locks in late August and continue through early to mid-November Warner, (E. Warner, MIT, 1998, pers. com., cited in the HCP).

When river flows rise with fall rain, coho begin to stage at the mouth of the Cedar River. If flows continue to stay high, coho will move upstream and locate preferred spawning habitat in small tributaries with adequate gravel. Cedar River coho are thought to begin spawning in mid-October and continue into February (CES, 1991).

4. Incubation and Early Rearing

The specific development rate and emergence timing of Cedar River coho has not been well documented. In most coho populations in this region, eggs hatch in about 2 to 3 months. Alevins remain in the gravel for an additional 2 to 3 months sustained by their yolk sac (Sandercock, 1991). Coho fry probably begin to emerge from the gravel in the Cedar in early March and continue through late May with peak emergence in mid-April (City 1998).

Juvenile coho rear in freshwater for at least 1 year. After a short period of schooling behavior immediately after emergence, coho fry become territorial and typically maintain distinct feeding territories during daylight hours (Sandercock 1991). Some coho may remain in the same tributary for a full year before they migrate downstream. Others may migrate downstream to larger streams or possibly to the lake to continue rearing prior to smoltification the following spring. However, the role of Lake Washington in juvenile coho rearing and migration is not well understood.

After rearing for approximately 1 year in fresh water, most juvenile coho undergo the process of smoltification and migrate to salt water. Sizes of Cedar River coho smolts are suggested by preliminary fry trapping data (D. Seiler, WDFW, pers. com., 1999). Smolts of average length 107 mm (ranging from 86 to 154 mm) were trapped by a rotary-screw trap in mid-March, 1999. Peak emigrations began in early May and extended through late May, when average lengths were about 104 mm (ranging from 82 to 165 mm). Smolts apparently emigrated in at least two distinct periods during the trapping season of mid-March to late July, 1999.

5. Distribution in the Marine Environment

Once in the marine environment, coho from the Cedar River are assumed to undergo migrations similar to other coho from the Puget Sound region. This migration takes coho primarily northward into the coastal waters of British Columbia (WDF 1975). Coho salmon released from Puget Sound are recovered in Washington, British Columbia, and Oregon, with essentially no recoveries from Alaska or California (NMFS 1995).

D. Steelhead Trout

Steelhead trout are rainbow trout that display an anadromous life history pattern. Steelhead trout inhabit Pacific coast streams of North America and northern Asia. The original native range of North American steelhead extends southward from the northern side of the Alaska Peninsula to northern Mexico. The present range is somewhat smaller because human activities have virtually eliminated steelhead populations south of San Francisco. In western Washington, steelhead are present in most Puget Sound drainages, coastal streams, and tributaries of the lower Columbia River (NMFS 1996).

1. Stock Origin and Current Status

The Lake Washington Basin is considered to have only 1 stock of native/wild steelhead trout (WDF et al., 1993). Historically, natural production has occurred in the Cedar River, Issaquah Creek, and north Lake Washington tributaries such as Bear Creek and the Sammamish River (WDF et al., 1993). The Lake Washington steelhead stock is considered to be depressed, and there is no longer substantial natural production from any stream in the basin other than the Cedar River (S. Foley, WDFW, 1997, pers. com., cited in the HCP).

Hatchery steelhead have been planted extensively throughout the Lake Washington and Lake Sammamish basins with the first recorded plant occurring in 1915 (Ajwani, 1956, cited in the HCP). Between 1915 and 1954, over 1,073,000 steelhead fry were planted in the Lake Washington watershed (Ajwani, 1956, cited in the HCP). Additional hatchery plantings were made in the Cedar River and other Lake Washington and Lake Sammamish tributaries between 1954 and 1993 and the last steelhead planting to occur in the Cedar River was in 1993 (WDF et

al., 1993). Like many early artificial production programs, the effectiveness of the early steelhead plantings was not rigorously monitored. Available data indicate that estimated levels of hatchery introgression among wild Cedar River steelhead is low as compared to other wild steelhead stocks in the region (Phelps et al., 1994, cited in the HCP). In 1997, WDFW, in cooperation with MIT and Trout Unlimited, started a wild broodstock program designed to incubate and rear Cedar River steelhead for out-planting in Issaquah and Bear Creeks, with the intent of re-establishing the species in these streams.

As previously mentioned, the status of the Washington basin steelhead, of which the Cedar River run is the largest component, was deemed depressed in the WDF Salmon and Steelhead Stock Inventory (1993), a report developed prior to the lowest recorded return (70 fish) in 1994. Between 1983 and 1997, escapement estimates for the Lake Washington basin ranged from 2,575 fish in 1983 to 70 fish in 1994 (all of which were in the Cedar River). The average escapement for this time period was 800 fish. Very low returns in the early 1990s resulted in the closing of all recreational fisheries in the Cedar River until steelhead numbers return to healthy levels. Since the record low return in 1994, steelhead escapement estimates have varied each year from 126 fish in 1995 to 616 fish in 1997, 580 in 1998, and 223 in 1999 (R. Little, SPU, pers. com., 1999).

2. Life History Overview

Steelhead are anadromous fish that home to their natal rivers to spawn. They exhibit an iteroparous life history (do not die after spawning) unlike the semelparous Pacific salmon. Steelhead populations are typically divided into two seasonal races of fish that are primarily defined by the timing of adult returns to spawning streams and by the state of sexual maturity upon entry into fresh water (NMFS 1996). Summer steelhead, or stream-maturing type, return to fresh water between May and October, and winter steelhead, or ocean-maturing type, return to fresh water between November and April (NMFS 1996).

Cedar River steelhead are a coastal population of winter race fish. Since the re-routing of the Cedar River in about 1915, adult steelhead enter Lake Washington through the Ballard Locks between December and early May (WDF et al. 1993). They spawn primarily in the mainstem from March through early June (Burton and Little, 1997, cited in the HCP), although there are historic records of steelhead spawning in Cedar River tributaries such as Rock Creek (below Landsburg).

3. Spawning

Steelhead spawning behavior is similar to that of other salmonids. The female locates an area of suitable substrate where she digs a depression in the gravel forming a nest. Males compete to court the female and fertilize her eggs as they are extruded. Studies in Alaska and Canada

suggest that approximately 80 percent of repeat spawners are females (Hooton et al., 1987; Didier, 1990, all cited in the HCP).

Steelhead trout take advantage of a wide range of spawning habitats including large mainstem habitats and small perennial streams. Steelhead usually spawn in medium to high gradient sections of streams at the tails of pools or at the heads of riffles, where hydrologic conditions maintain adequate intergravel flows that provide an oxygenated environment for egg incubation (Greeley, 1932; Orcutt, et al. 1968, all cited in the HCP).

4. Incubation and Rearing

Steelhead typically hatch between 4 and 8 weeks after fertilization and the larval fish (alevins) remain in the redd for an additional 3 to 5 weeks, absorbing nutrients from a yolk sac connected to their abdomen. Emergence studies occurring in the Cedar River in 1996 and 1997 indicate that fry emergence for an individual redd begins approximately 54 days after fertilization and is complete approximately 63 days after fertilization (Burton and Little, 1997, cited in the HCP). The emergence period for Cedar River steelhead lasts from late May to early August with peak emergence occurring in mid- to late July (Burton and Little, 1997, cited in the HCP).

Steelhead typically reside in the stream for 2-3 years, although a small number of fish may out-migrate after 1 year (NMFS 1996). Cedar River steelhead rear in the mainstem and tributaries below Landsburg Diversion Dam. The majority of Cedar River fish are believed to emigrate as smolts after 2 years of freshwater residence. Size, not age, is the main determinant in smolt emigration. Smolt emigration in 1999, based on the rotary-screw trap data (D. Seiler, WDFW, pers. com., 1999) showed a peak in early May. Smolt sizes averaged 172 mm and ranged from 94 to 272 mm. Fish from less productive systems take longer to reach smolt size and, therefore, are older when they begin to migrate to the ocean. Cedar River steelhead smolts tend to attain large sizes compared to other local and regional stocks (S. Foley, WDFW, 1997, pers. com., cited in the HCP).

5. Distribution in the Marine Environment

Generally, steelhead emigration from fresh water occurs in the spring between mid-March and early June. The peak of the smolt migration usually coincides with peak spring runoff in mid-April to mid-May. The majority of steelhead smolts appear to migrate directly to the open ocean and do not spend substantial amounts of time in the estuarine or coastal environments around their birth stream (Burgner 1991). Timing of Cedar River steelhead smolt emigration is not well understood, although there are ongoing studies being conducted at the Ballard Locks (City 1998).

After spending 2-3 years in the ocean, the majority of steelhead become mature and leave their feeding grounds to migrate back to their birth stream. In Puget Sound, very few fish return after

only 1 year in the marine environment, and some fish remain in the ocean for up to 6 years (WDF et al., 1993).

E. Coastal Cutthroat Trout

Coastal cutthroat trout are a common Washington native fish species found in coastal and Puget Sound streams. Coastal cutthroat trout are abundant in streams draining into Lake Washington and support a substantial sport fishery (R. Pfeifer, WDFW, 1998, pers. com., cited in the HCP); however, the Cedar River is closed to sportfishing (WDFW, 1997). Cutthroat trout are also an important component of the Lake Washington ecosystem and provide an important ecological niche as a top predator (City 1998).

1. Stock Origin and Current Status

Cutthroat trout (*O. clarki*) exhibit considerable diversity in geographic range, life history, and ecology and have been divided into 13 subspecies. The coastal cutthroat trout (*O. clarki clarki*) subspecies that is found in the Cedar River Watershed is native to Puget Sound streams and the Cedar River (NMFS 1999).

The population in the Cedar River watershed is likely a native stock, although coastal cutthroat were stocked in numerous Washington streams as early as 1895 (Crawford 1979, cited in the HCP). Cutthroat trout have been stocked in the Cedar River to some extent beginning in 1915 (HRC, 1995, cited in the HCP). Stocking records indicate that cutthroat trout were stocked in the Cedar River Watershed in 1920, but there is no indication of planting location (Department of Fisheries and Game, Thirtieth and Thirty-First Annual Reports, cited in the HCP).

In general, adult coastal cutthroat trout tend to spawn in the extreme upper reaches of small streams, ascending above the areas utilized by other anadromous salmonids. For this reason, it is likely that anadromous cutthroat at one time, prior to the time the Cedar River was re-routed into Lake Washington, ascended into stream basins between Landsburg and Lower Cedar Falls (e.g., the Williams Creek, Rock Creek, and Steele Creek subbasins). These subbasins are now dominated by stream-resident cutthroat trout, suggesting that accessible reaches may have been used by coastal cutthroat trout prior to construction of the Landsburg Dam. The quality of stream habitat for spawning cutthroat depends on water temperature, water quality, and habitat complexity, which in turn depend, at least in part, on the condition of riparian vegetation. Potential key habitat in the municipal watershed for coastal cutthroat trout includes all habitat currently used by resident cutthroat trout that is located below natural barriers to upstream migration. Thus, key habitat includes streams in the lower municipal watershed and their associated riparian habitat. As described below, habitat in the Cedar River below Landsburg that is influenced by City management of instream flows may also be important.

Coastal cutthroat trout exhibit a variety of population forms, including anadromous, adfluvial (i.e., migrating to streams to spawn while rearing in an adjacent lake), and stream resident (NMFS 1996). Prior to the historic diversion of the Cedar River into Lake Washington and construction of the Landsburg Dam, anadromous populations of coastal cutthroat trout are suspected to have migrated into the Cedar River watershed, based on their ubiquitous distribution. Adult coastal cutthroat trout spawners tend to utilize the extreme upper reaches of small streams, ascending above the areas utilized by other anadromous salmonids (NMFS 1996). For this reason, it is likely that anadromous cutthroat at one time ascended into stream basins to the north of the Cedar River mainstem downstream of Cedar Falls (e.g., Williams, Rock, Walsh, and Steele stream basins). These basins are now dominated by stream resident cutthroat trout, suggesting that accessible reaches may have been used by coastal cutthroat trout prior to river alterations previously described.

Coastal cutthroat trout are not found in the Cedar River Municipal Watershed above the Landsburg Diversion Dam, although resident cutthroat are present in high numbers within the watershed below the Lower Cedar Falls. Additionally, it is not known what proportion of the Cedar River cutthroat trout population downstream of the Landsburg Diversion Dam is the anadromous coastal cutthroat trout. There are no records indicating that coastal cutthroat trout use the fish ladder at the Ballard Locks. However, large cutthroat trout have been observed in the Cedar River downstream of the Landsburg Diversion Dam, which suggests that some fish may have an anadromous or potentially adfluvial life history. Coastal cutthroat trout use of the streams that flow into Lake Washington is poorly understood. Stream resident cutthroat are widely distributed in the Taylor Creek drainage and tributaries to the Cedar River downstream of Cedar Falls. No cutthroat trout have been observed within the Masonry Pool or Chester Morse Lake and its tributary streams, which suggests that the original natural barrier to anadromous fish passage at Cedar Falls controlled their distribution in the watershed.

F. Sockeye Salmon

The sockeye salmon, *Oncorhynchus nerka*, is a common and relatively well-studied species of the family Salmonidae. Spawning populations of sockeye have been reported from the Sacramento River in the south to the rivers of Kotzebue Sound in the north, and east to basins that drain into the Sea of Okhotsk (Burgner 1991). Size at maturity varies considerably between and within populations of sockeye, with larger fish typically spending additional time at sea. The average weight of sockeye returning to the Cedar River is approximately 5.25 pounds (James M. Montgomery Inc. 1990, cited in the HCP).

Sockeye are an important component of the Lake Washington ecosystem. Post-spawning salmon carcasses contribute nutrients to the biotic communities in streams and lakes (Kline et al. 1994; Bilby et al. 1996, cited in the HCP). Returning spawners excavate and, to some degree,

redistribute substantial amounts of gravel in spawning areas each year (Burgner 1991). A number of fish species in the system feed upon sockeye eggs and juveniles (Foerster 1968; Stober and Hamalainen 1980; Beauchamp 1993; Tabor and Chan 1996; all cited in the HCP). Birds and mammals scavenge on carcasses (Cederholm et al. 1989, cited in the HCP), and a number of bird species, such as dippers, kingfishers, and mergansers, feed on eggs and juvenile fish (Burgner 1991). During their extended rearing period in the lake, juvenile sockeye are important predators that consume substantial amounts of zooplankton (Foerster 1968; Woodey 1972; Chigbu and Sibley 1994; all cited in the HCP).

Sockeye salmon are the most numerous naturally reproducing salmonids in the basin and, in years of high abundance, the population has supported a significant Tribal treaty harvest and one of the largest sport fisheries in the state (Fresh 1994, cited in the HCP). The migration of sockeye through the fish ladder at the Ballard Locks attracts thousands of visitors each year. The observation of spawning sockeye in the Cedar River, Bear Creek, and Issaquah Creek has become a popular fall outdoor recreation activity for many people in the region.

The majority of sockeye returning to Lake Washington spawn in the Cedar River. The north Lake Washington subgroup of sockeye also exhibits substantial returns in some years. Returns to Issaquah Creek are typically lower than returns to the north-end tributaries. Lake spawners typically account for the smallest portion of the run, usually three orders of magnitude less than returns to the Cedar River (Hendry et al., 1996, cited in the HCP).

1. Kokanee

Kokanee (the land-locked form of sockeye salmon) typically occur in deep, cool freshwater lakes. Adults spawn in tributaries to these lakes, and fry return, upon emergence, to mature over a period of about 4 years (HCP Section 3.6.2). Their spawning requirements are similar to those of sockeye salmon, except that, because they are smaller fish, kokanee prefer relatively smaller-sized gravels for spawning. Some kokanee in Lake Washington have been known to spawn in gravel along parts of the lakeshore.

Kokanee were thought to have been present in Lake Washington prior to the turn of the twentieth century, and, are still present in isolated populations. Although it is possible that anadromous sockeye may also have been present in small numbers, their presence was not conclusively determined prior to the introduction of Baker River fish in the 1930s (U.S. Fish Commission 1897; Cobb 1916; Burgner 1991; all cited in the HCP).

Kokanee have recently been documented in Walsh Lake, and spawning activity has been confirmed in Webster Creek, the main tributary to Walsh Lake (HCP Appendix 23). It is unknown whether this population is native to the lake or is the result of plant(s) sometime during the last several decades. Although kokanee were not collected during a 1977 University of

Washington fish survey (Congelton et al. 1977, cited in the HCP) and were not mentioned in water quality reports from the 1920s, the sampling methods in these efforts may not have been satisfactory to support a conclusion that kokanee were absent at those times.

The quality of stream habitat for spawning kokanee depends on water temperature, water quality, and habitat complexity, including availability of pools, substrate structure, and cover (e.g., woody debris). Such habitat conditions depend, at least in part, on the condition of riparian vegetation and the extent of sediment loading from anthropogenic sources. Potential key habitat for kokanee in the municipal watershed include Walsh Lake and its tributaries, as well as riparian habitat associated with the lake and its tributaries.

2. Stock Origin and Current Status

WDF et al. (1993) identified four populations of anadromous sockeye salmon in Puget Sound: one population in the Baker River and three populations that occur in the Lake Washington watershed (Cedar River, Issaquah/Bear Creek, and Lake Washington beach spawners). Genetic research suggests that there are two subgroups in the Lake Washington watershed: a potentially native stock that spawns in Bear and Cottage Creeks at the north end of the system and a second stock derived from transplants of Baker River sockeye in the 1930s and 1940s that spawns in the Cedar River, Issaquah Creek, and on the beaches of Lake Washington (City 1998).

After building to relatively robust levels in the 1960s and 1970s, the Lake Washington sockeye population experienced a period of significant decline. The mean spawner return ratio during the 11 brood years for which full return data is available is 0.79. This means that, on average, for each 100 fish that successfully spawn in the basin, only 79 fish have returned to spawn in the subsequent generation. Since record keeping began in 1967, the escapement goal for the system of 350,000 adult fish has been met or exceeded five times. Since the escapement goal was last achieved in 1996, the mean run size has been approximately 135,000 fish (WDFW unpublished data, cited in the HCP). WDF et al. (1993) classify the Lake Washington sockeye population as depressed in the Cedar River and elsewhere in the basin.

Sockeye harvest opportunities have recently declined in frequency. In 8 of the 22 years between 1967 and 1988, Tribal and sport fishers harvested substantial numbers of sockeye in Lake Washington. Since 1988, Tribal and sport harvests have been conducted in Lake Washington only in 1996 (WDFW, unpublished data, cited in the HCP). Although the 1996 return of approximately 450,000 adult fish indicates that the system has retained some potential to produce substantial numbers of fish, the general trend in the sockeye population remains one of relatively steep decline.

3. Life History Overview

Sockeye salmon exhibit a typical salmon life history pattern that integrates anadromy (juveniles migrate to the ocean where they mature and return as adults to spawn in fresh water), homing (adults generally return to their natal streams to spawn), and semelparity (adults die after spawning once). Sockeye can also exhibit a resident life history that is similar to the typical pattern, but lacks the feature of anadromy (Burgner, 1991). These resident sockeye are called kokanee. Although small numbers of sockeye in the Lake Washington basin exhibit the resident life history pattern, including a population in Walsh Lake in the Cedar River watershed, the vast majority of the population is anadromous. Unlike any of the other species of Pacific salmon, juvenile sockeye rear primarily in freshwater lakes.

4. Upstream Migration and Spawning

Adult sockeye salmon begin returning to the Lake Washington watershed through the Ballard Locks in late May with a peak migration in early July. By mid- to late August, essentially all fish have entered the lake (E. Warner, MIT, 1998, pers. com., cited in the HCP). Once in the lake, the fish move into deep, cold areas below the thermocline. Adults spend from 1 to 4 months in this region of the lake, where they undergo final sexual maturation (Parametrix, Inc., 1991, cited in the HCP). Most fish move into tributary streams to spawn during the fall, but a relatively small proportion of the population spawn in selected beach areas along the eastern shores of the lake and along the northern shoreline of Mercer Island in the south part of Lake Washington. The Cedar River supports the largest population of sockeye salmon in the Lake Washington basin, with numbers of fish also spawning in the Bear Creek sub-basin, and in North Creek, Swamp Creek, and Issaquah Creek. Although there have been exceptions in some years, approximately 90 percent of the returning fish typically spawn in the Cedar River (James M. Montgomery Inc., 1990; WDFW unpublished data; all cited in the HCP).

Cedar River sockeye exhibit relatively protracted periods of spawning and incubation. Mature adults begin to enter the Cedar River in early September. Spawning activity begins to increase in mid-September and continues into January with a peak in mid- to late October (CES, 1991). Each female selects a site for spawning, digs a redd, and deposits an average of 3,200 eggs.

5. Incubation and Early Rearing

Alevins hatch from the eggs after 2 or 3 months and remain in the gravel for an additional 2 to 4 months, during which time they are sustained by their yolk sacs as they complete their development into free-swimming fry (Foerster, 1968; James M. Montgomery Inc., 1990, cited in the HCP).

Fry begin to emerge from the gravel in late January and continue through May, with a peak in late March and early April. Upon emergence, fry immediately begin migrating downstream. Most fry arrive at Lake Washington within 48 hours of emergence (Seiler and Kishimoto, 1996,

cited in the HCP). Most juvenile sockeye reside in the lake for approximately 12-14 months, then undergo the process of smoltification as they migrate out of the lake into salt water via the Lake Washington Ship Canal and the Ballard Locks. These migrating smolts move out of the lake and into Puget Sound between April and June (James M. Montgomery Inc., 1990, cited in the HCP).

6. Distribution in the Marine Environment

After leaving Puget Sound, subadult sockeye move north along the continental shelf, into the Gulf of Alaska, and then migrate south into the open ocean. Once they reach maturity, the adult fish return to near-shore waters and migrate south along the coastline to Puget Sound and back to Lake Washington. The majority of Lake Washington sockeye return after 2 years at sea, however, a substantial proportion from any give year class may return after 3 years at sea. Typically, a very small portion of the population (less than 1 percent) returns after only 1 year at sea (WDFW unpublished data, cited in the HCP).

IV. ENVIRONMENTAL BASELINE

The environmental baseline for the anadromous salmonid species that inhabit the area covered by the HCP includes the past and present effects of all Federal, State, or private activities in the action area, the anticipated effects of all proposed Federal projects in the action area that have already undergone formal or early section 7 consultation, and the effect of State or private actions which are contemporaneous with the consultation in progress (50 C.F.R. ' 402.02). As stated earlier, all but chinook of the anadromous salmonid species analyzed herein are presently unlisted, and there have not yet been any section 7 formal consultations on chinook within the action area. This analysis will focus on the past and present effects of all Federal, State, or private activities in the action area.

A. Summary Synthesis of Species' Status and Environmental Baseline

- Cedar River anadromous fish species are: (ESA-threatened) PS chinook salmon (*Oncorhynchus tshawytscha*), (unlisted but depressed population) coho salmon (*O. kisutch*), (unlisted, but depressed population) steelhead trout (*O. mykiss*), (introduced and healthy population) sockeye salmon (*O. nerka*), and (unlisted and likely healthy) coastal cutthroat trout (*O. clarki*) within the HCP.
- PS chinook in the Cedar River are considered to be an indigenous, naturally spawning population, that is genetically unique, and is one of 18 core populations within the ESU.
- The Cedar River Municipal Watershed is currently inhabited by only non-anadromous salmonids. Manmade barriers to upstream adult fish passage are located at the water pipeline

crossing at RM 21.4 and near the downstream limit of City lands at the Landsburg water diversion dam at RM 21.8.

- City lands above Landsburg are mostly forested and have largely regrown since widespread logging about 50 to 70 years ago. Water quality is high on City lands, which are managed for a municipal water source.
- Prior to the installation of the Landsburg Diversion Dam and pipeline in the early twentieth century, PS chinook, coho salmon, and steelhead trout were believed to have used the Cedar River and accessible tributaries up to Cedar Falls, which is a natural passage barrier at RM 34.2. Around 1912, the Cedar River was re-routed from its junction with the Black River, that flowed into Duamish River and Elliot Bay, to instead flow into Lake Washington, which has an outlet at the Ballard Locks.
- The existing regime of instream flows, while not binding on the City, has been structured to attempt to provide for spawning, rearing, and migration needs for anadromous fish within the 21.8 miles of Cedar River from Landsburg Diversion Dam to the mouth.
- A draft recovery plan, prepared by local Tribes and WDFW, for Lake WA chinook identified a number of likely limiting factors in the Lake WA basin: altered flows, degraded water quality, altered sediment routing, degraded riparian forest functionality, loss of floodplains and wetlands, loss of lake littoral habitats, reduced access by fish, mixed-stock fisheries, interactions with hatchery stocks, and changes in numbers and distribution of competitors and predators.

B. Puget Sound Chinook

Cedar River populations are addressed in detail in section II. The NMFS status review and addendum describe the conditions for PS chinook over the entire ESU (NMFS 1998a, 1998b). Chinook salmon abundance in watersheds throughout the Puget Sound ESU appears to be closely correlated with hatchery effort. The recent stock assessment by WDF et al. (1993) identified 28 fall- and spring-run chinook salmon stocks in Puget Sound from the Nooksack River to the Elwha River. Seventeen of these 28 stocks were reported to be naturally produced runs, reflecting evidence that hatchery fish have had little or no influence on the spawning grounds. The status of 15 of the 17 (88%) natural Puget Sound chinook salmon stocks was classified as "critical," "depressed," or "unknown" (WDF et al. 1993). Cedar River stocks were deemed "unknown." On the other hand, WDF et al. (1993) reported that 6 of the 28 Puget Sound chinook salmon stocks were of "mixed production," based on a conclusion that hatchery fish have made a significant contribution to the spawning population. All six hatchery-influenced stocks have been designated as "healthy." Therefore, there are several river systems in which a constant infusion of hatchery fish appears to have maintained population abundance to the point that the stocks have been determined to be healthy, albeit "mixed," (i.e., "a stock whose individuals originated from commingled native and non-native parents, and/or by mating between native and non-native fish (hybridization); or a previously native stock that has undergone substantial genetic

alteration”).

The 5-year geometric mean of spawning escapement of natural chinook salmon runs in North Puget Sound for 1992-96 is approximately 13,000. Both long- and short-term trends for these runs were negative, with few exceptions. In south Puget Sound, which includes the Cedar River, spawning escapement of the natural runs has averaged 11,000 spawners. In this area, both long- and short-term trends are predominantly positive.

Previous assessments of stocks within this ESU have identified several stocks as being at risk or of concern. Nehlsen et al. (1991, cited in NMFS 1998a) identified four stocks as extinct, four stocks as possibly extinct, six stocks as at high risk of extinction, one stock as at moderate risk (White River spring run), and 1 stock (Puyallup River fall run) as of special concern. WDF et al. (1993) considered 28 stocks within the ESU, of which 13 were considered to be of native origin and predominantly natural production. The status of these 13 stocks was: 2 healthy (Upper Skagit River summer run and Upper Sauk River spring run), 5 depressed, 2 critical (South-Fork Nooksack River spring/summer run and Dungeness River spring/summer run), and 4 unknown. The status of the remaining (composite production) stocks was eight healthy, two depressed, two critical, and three unknown. The Nooksack/Samish River fall run and Issaquah Creek summer/fall run were not considered an ESA issue by the NMFS Biological Review Team (stocks were not historically present in the watershed or current stocks are not representative of historical stocks) but were included to give a complete presentation of stocks identified by WDF et al. (1993).

1. Habitat

Habitat throughout the ESU has been blocked or degraded. In general, upper tributaries have been impacted by forest practices and lower tributaries and mainstem rivers have been impacted by agriculture and/or urbanization. Diking for flood control, draining and filling of freshwater and estuarine wetlands, and sedimentation due to forest practices and urban development are cited as problems throughout the ESU (WDF et al. 1993). Blockages by dams, water diversions, and shifts in flow regime due to hydroelectric development and flood control projects are major habitat problems in several basins. Bishop and Morgan (1996) identified a variety of habitat issues for streams in the range of this ESU including 1) changes in flow regime (all basins), 2) sedimentation (all basins), 3) high temperatures (Dungeness, Elwha, Green/Duwamish, Skagit, Snohomish, and Stillaguamish Rivers), 4) streambed instability (most basins), 5) estuarine loss (most basins), 6) loss of large woody debris (Elwha, Snohomish, and White Rivers), 7) loss of pool habitat (Nooksack, Snohomish, and Stillaguamish Rivers), and 8) blockage or passage problems associated with dams or other structures (Cedar, Elwha, Green/Duwamish, Snohomish, and White Rivers). The Puget Sound Salmon Stock Review Group (PSSSRG 1997, cited in NMFS 1998a) provided an extensive review of habitat conditions for several of the stocks in this ESU. It concluded that reductions in habitat capacity and quality have contributed to escapement

problems for Puget Sound chinook salmon. It cited evidence of direct losses of tributary and mainstem habitat, due to dams; of slough and side-channel habitat, caused by diking, dredging, and hydro-modification; and also cited reductions in habitat quality due to land management activities.

Human activities have degraded extensive areas of chinook salmon spawning and rearing habitat in Puget Sound. Development activities have limited access to historical spawning grounds and altered downstream flow and thermal conditions. Urbanization effects many part of the aquatic environment. It has caused direct loss of riparian vegetation and soils, significantly altered hydrologic and erosional rates and processes by creating impermeable surfaces (roads, buildings, parking lots, sidewalks etc.), and polluting waterways. Large areas of lower river meanders that were formerly mixing zones between fresh and salt water have been channelized and diked for flood control and to protect agricultural, industrial and residential development. In spite of this, habitat degradation in upstream areas has exacerbated flood events in these areas—with adverse effects on chinook salmon populations. In some rivers, such as the Elwha, increased water temperatures have decreased salmonid's disease resistance.

Water diversions and hydroelectric dams have prevented access to portions of several rivers. Furthermore, the construction of Cushman Dam on the North Fork of the Skokomish River may have created a residualized population of chinook salmon in Lake Cushman. Within the Puget Sound region, approximately seven major dams block access to historic chinook salmon spawning and rearing habitat. Other dams blocking historic spawning and rearing habitat include: (1) Elwha and Glines Canyon Dam on the Elwha River, (2) Howard Hansen Dam on the Green River, (3) *Cedar Falls Dam on the Cedar River*, (4) Gorge Falls Dam on the Skagit River, and (5) Baker Dam on the Baker River. Passage at Ballard Locks (Lake Washington) also poses problems for downstream juvenile chinook salmon migrants.

2. Harvest

The peak chinook salmon harvest in Puget Sound was recorded in 1908 when 95,210 cases of canned chinook salmon were packed. This corresponds to a run size of approximately 690,000 chinook salmon at a time when both ocean harvest and hatchery production were negligible. This estimate, as with most historical estimates, needs to be viewed cautiously: Puget Sound cannery pack probably included a portion of fish that were landed at Puget Sound ports but originating in adjacent areas. Consequently, the estimates of exploitation rates used in run-size expansions are not based on precise data. Recent mean spawning escapements totaling 71,000 correspond to a run entering Puget Sound of approximately 160,000 fish. Allowing for an exploitation rate of 1/3 in intercepting ocean fisheries yields a recent average potential run size of 240,000 chinook salmon (PSC 1994, cited in NMFS 1998b).

Fisheries in Puget Sound have been managed inaccurately due to the failure to identify correct

“maximum sustainable yield” (msy) rates given declining productivity of natural chinook salmon stocks. High harvest rates directed at hatchery stocks have caused many stocks to fail to meet natural escapement goals in most years (USFWS 1996). The 5-year geometric mean natural spawning escapement in most Puget Sound streams has been 1,100 adult chinook salmon. This figure varies widely and has both negative short- and long-term trends (except in the Dosewallips River). Harvest impacts on Puget Sound chinook salmon stocks have been quite high. Ocean exploitation rates on natural stocks averaged 56% to 59%, and total exploitation rates average 68% to 83% during the 1982-89 brood years (PSC 1994, cited in NMFS 1998b). Total exploitation rates on some stocks has exceeded 90% in recent years (PSC 1994, cited in NMFS 1998b).

3. Hatcheries

Fall-, summer-, and spring-run chinook salmon stocks are artificially propagated in Puget Sound. Currently, the majority of production is devoted to fall-run (also called summer/fall) stocks for the purpose of fisheries enhancement. Conversely, because of the depressed nature of spring- and summer-run stocks, approximately half of the stocks recognized by WDF et al. (1993) are under captive culture or supplementation recovery programs. Captive broodstock/recovery programs for spring-run chinook salmon have been undertaken on the White River (Appleby and Keown 1994, cited in NMFS 1998b), and the Dungeness River (Smith and Sele 1995, cited in NMFS 1998b). Supplementation programs currently exist for spring-run chinook salmon on North Fork Nooksack River and summer-run chinook salmon on the Stillaguamish and Skagit Rivers (Marshall et al. 1995, Fuss and Ashbrook 1995, cited in NMFS 1998b).

Due to the small size of these spawning populations the potential for inadvertent selection, inbreeding, or accidental loss is heightened while they are under artificial propagation. Fall run transfers between Puget Sound, Washington Coast, and Lower Columbia ESUs were commonplace earlier in this century. Since the 1950s, transfers between ESUs were greatly reduced, but within ESU transfers have been commonplace. One of the greatest impacts has been the widespread use of Green River fall-run chinook salmon in a number of hatchery programs throughout Puget Sound. Marshall et al. (1995, cited in NMFS 1998b) lists 30 artificial propagation programs throughout this ESU that use stocks which have received large transfers of Green River fish. The use of delayed release programs from net-pen to enhance Puget Sound sport fisheries increases the potential for artificially produced fish to stray into nonnative watersheds. Given the magnitude of artificial propagation programs in this ESU, it is probable that hatchery-produced fish constitute a substantial proportion of naturally spawning fish in many Puget Sound Basins. Where specific information on the influence of strays is not known it is possible that the productivity of many natural populations is inflated.

C. Lands Adjoining the Cedar River Watershed

Adjoining lands covered under existing HCPs, but located outside the Cedar River watershed include forest lands managed by WA Department of Natural Resources, and managed by Plum Creek Timber. Both of those land owners managed their timber lands in the vicinity of the Cedar River watershed according to separate HCPs that have been determined by NMFS to comply with ESA (see Findings documents January 1997 and June 1996 respectively, on file with NMFS in Lacey, WA).

D. Cedar River Watershed

1. Fish Numbers and ESU Context

Annual counts of chinook spawners for the period from 1989 to 1996 averaged 420 fish in the Cedar River. Recent numbers have varied: 227 in 1997, 432 in 1998, and 241 in 1999. Assuming an average of 400 fish in the Cedar, this represents about 1 to 2% of the total number of natural spawners for the entire ESU. But that fraction alone may under-represent the potential contribution of the Cedar River as one of approximately 18 core populations of chinook within the Puget Sound ESU. Core populations are genetically unique populations indigenous to watershed within Puget Sound and would be the highest priority for recovery under an approach in development by NMFS called Viable Salmonid Populations.

2. Fish Distribution

Historically, anadromous fish migrated to the Cedar River via the Duwamish and Black Rivers. CES (1991) summarizes the species suspected to have once occurred in the Cedar River. Chum salmon (*Oncorhynchus keta*), pink salmon (*O. gorbuscha*), sockeye salmon, coho salmon, chinook salmon, and steelhead and cutthroat trout were thought to be present in the Cedar River prior to the man-made barriers in about 1916. The historic upstream extent of these species is unclear, but, prior to the installation of the Landsburg Diversion Dam and pipeline in the early twentieth century, coho salmon, chinook salmon, and steelhead trout were believed to have used the Cedar River and accessible tributaries up to Cedar Falls, which is a natural passage barrier at River Mile (RM) 34.2. An impassable waterfall barrier near its confluence with the Cedar River precludes use by anadromous fish in the Taylor Creek drainage as well. Non-anadromous salmonids occur throughout the upper Cedar River and Taylor Creek watersheds upstream of natural barriers, although cutthroat have not been observed upstream of the anadromous fish passage barrier at Cedar Falls.

3. Watershed Conditions

Details of the hydrologic reconfiguration of the Cedar River basin, the Landsburg Diversion Dam, the land management history, and summary results of a Watershed Assessment (conducted in 1995) are all presented in the HCP (City 1998) and are summarized below. Baseline

conditions for the channel, hydrology and watershed of the Cedar River are described in detail in Section 3.2 of the EA and sections 3.2, 3.3, 3.4, 3.5, and 3.6 of the HCP. Appendix 15 to the draft HCP also summarizes existing watershed conditions within the City's ownership.

Generally, water quality and instream habitat conditions above Landsburg Dam are favorable to support all species of anadromous salmonids.

Instream habitats in the Cedar River between Landsburg and the natural barrier at Cedar Falls are further described in the Cedar River Watershed Assessments (Seattle Water Department 1995). Since the conditions of mainstem channels and large woody debris (LWD) have been a focus of plan comments, the full text of those sections are repeated below:

a. Mainstem Conditions

The channel of the canyon portion of the mainstem is tightly confined in steep-sided, V-shaped valleys with attendant high transport capacities. Bedrock outcrops are scattered throughout. Boulder cataract and step-pool channels are the norm, with large boulder clasts providing the primary roughness elements. Large, woody debris plays a minor role in controlling channel morphology.

Downstream, the channels gradient moderates to less than 2 percent. The channel remains moderately confined within gently sloping valley sideslopes. A narrow floodplain of boulder and large cobble material borders the channel. The channel bed is composed predominantly of large cobbles and boulders. In general, deep pools resultant from vertical bed oscillations, with no apparent pool initiation structure. Extensive areas of plane-bed pocket waters or boulder-studded runs are common. Occasional large boulder clusters create hydraulics conducive to development of deep scour-pools. Gravel beds are common associated with channel margins or pool tailouts.

b. LWD recruitment

Forest regrowth has progressed on streams previously harvested to stream-side to where no short or long term recruitment deficiencies were noted. The small size of the tributary streams preclude the need for large diameter logs to work effectively. Nevertheless, much of the stream adjacent forest are well advanced, and support trees with diameters exceeding 16 inch dbh.

Wood contributed to the mainstem that is generally of insufficient size create channel hydraulics conducive to pool development or to effectively act as a key piece that would serve to trap other wood. Lateral concentrations of wood are currently the primary source of habitat associated with organic debris. Nevertheless, because of stream size and power, pools are formed largely by bedform and boulder clusters. An increase in larger diameter old-growth size trees would help increase margin rearing habitats and cover, but would not result in major changes to channel hydrology.

4. Existing Instream Flow Regime

In 1979, WDOE established an instream flow regime for the Cedar River as part of the Instream Resource Protection Program (IRPP) (WAC 173-508). Since that time, the City has asserted that its water claim is senior by many decades, and therefore superior to the 1979 flow regime. This position has not been adjudicated by WDOE since state statute protects existing rights from newly established minimum instream flow requirements. As a result, the flows proposed for the Cedar River by the IRPP have never been legally binding on the City.

The IRPP was developed in 1979 to determine minimum instream flow needs. The IRPP resulted in the current non-binding minimum instream flows provided voluntarily by the City and measured at Renton. During a year with normal precipitation levels minimum flow requirements range from 130 to 370 cfs depending upon the time of year. No minimum instream flows are currently required upstream of the Landsburg Dam.

Even though the City's claim to the Cedar River predates the authority of Washington State to impose instream flow requirements, the City's Water Supply Plan expressed the City's intent to gradually phase in the IRPP flows through a non-binding approach by 2003. This non-binding flow regime, as outlined below, was developed 20 years ago from recommendations from the ACOE, WDOE, WDF, and the University of Washington Fisheries Resource Institute (FRI). Instream flow incremental methodologies (IFIM), and other technical investigations typically used today for determining instream flow needs were not available when the IRPP flows were established. For the first time, the concept of a Acritical® minimum instream flow regime was introduced for the Cedar River. This concept involves establishing a lower instream flow standard for use in very dry years, as opposed to having the same set of flows apply every year regardless of climate conditions.

The IRPP flows were developed near the end of the latter of two instream flow studies. The first study was conducted by the USGS and WDF between 1967 and 1969 (Collings et al., 1970, cited in CES, 1991). Between 1972 and 1980, a second instream flow study was conducted by the FRI under contract to the Seattle Water Department (SWD). Concerns over the appropriateness of the IRPP flows resulted in a third effort to determine the instream flow requirements for selected fish species. Consequently, a 10-year collaborative study program was funded by the City starting in 1987. The program was directed by the Cedar River Instream Flow Committee (CRIFC) consisting of SWD, the WDFW, the WDOE, the ACOE, the USFWS, the NMFS and the MIT. The program included four major study components: an Instream Flow Study using Instream Flow Incremental Methodology (IFIM), an Effective Spawning Analysis, a Cumulative Spawning Analysis, and a Risk Zone Analysis. The overall study purpose was to evaluate the instream flow and associated habitat requirements of salmon and steelhead in the Cedar River and provide a technical tool used by water and fisheries managers to allocate water between

instream uses and diversions.

The results of the completed program were published 1991 as the Cedar River Instream Flow and Salmonid Habitat Utilization Study (CES 1991). This report suggested that some improvements over the IRPP flows were possible for both increasing the available habitat and improving incubation conditions. The HCP Instream Flow regime is the negotiated outcome of that desire for more available habitat and improving incubation conditions.

Under a normal flow year as measured at the existing United States Geological Survey (USGS) gauging station No. 12.1190.00, Cedar River at Renton, the City will use the flows below as non-binding guidelines:

- 370 cfs from October 10 to June 20
- a linear decrease in flows from 370 cfs on June 20 to 130 cfs on July 15
- 130 cfs from July 15 to September 10
- a linear increase from 130 cfs to 200 cfs from September 10 to September 20
- 200 cfs from September 20 to October 1
- a linear increase from 200 cfs to 370 from October 1 to October 10.

If natural Cedar River flows fall below the flows expected to occur no more than 1 year out of 10 on average, then critical flows may be provided:

- 250 cfs from November 1 to June 15
- a linear decrease from 250 cfs to 110 cfs from June 15 to July 1
- 110 cfs from July 1 to October 1
- a linear increase from 110 cfs to 250 cfs from October 1 to November 1.

1. Puget Sound Chinook Salmon

Three stocks of chinook are present in the Lake Washington Watershed: (1) the Issaquah Creek stock, a composite population that is at least partially sustained by production from the Issaquah Hatchery; (2) the Cedar River stock, classified as native/wild; and (3) the north Lake Washington tributary stock also classified as native/wild. Annual counts of spawners for the period from 1989 to 1996 averaged approximately 1,600 fish in Issaquah Creek, 420 fish in the Cedar River, and 285 fish in the north Lake Washington tributaries (Smith, C., WDFW, 1998, pers.com., cited in the HCP). Recent genetic analyses indicate that Cedar River chinook are clearly members of the South Puget Sound, Hood Canal & Snohomish Summer/Fall chinook Genetic Diversity Unit described by Marshall et al. (1995, cited in the HCP). They are closely associated with the Green River Hatchery population but are distinct from this population and all other populations within the Genetic Diversity Unit. The degree to which the present Cedar River population has been

affected by past interbreeding with hatchery fish is not known, but is assumed to be minor (WDF et al. 1993; A. Marshall, WDFW, 1998, pers.com., cited in the HCP).

a. Altered Habitats

Although the aquatic habitat in the area between Lower Cedar Falls and Landsburg Dam was degraded by extensive timber harvest and other land use practices early in the twentieth century, much of the area has recovered to a substantial degree, according to the Watershed Assessment completed in 1995 (SWD 1995). Consequently, this portion of the watershed offers some of the best fish habitat in the Lake Washington basin, although it has been inaccessible to anadromous fish for nearly all of the past century. With provisions for sufficient releases of water from upstream storage facilities to meet instream flows requirements, this part of the watershed has the potential to provide excellent habitat for salmonids, after the HCP provisions to construct fish ladders and screens become operational. A robust population of rainbow trout, thought to be derived from the original stock of steelhead present before the construction of the diversion dam, currently occupies this habitat. There are relatively large inputs of high quality ground water throughout this reach. Erosion and sedimentation are largely in balance with other natural processes. Riparian zones are largely intact, and much of the stream channel is shaded by mature conifers (e.g., at least 60 years old). Instream conditions above Landsburg appear generally suitable for production of chinook salmon upon restoration of anadromous fish access (Appendix 15 of the HCP). Note there are no instream flow studies specific to the river above Landsburg so the extent to which salmon may be able to spawn and rear successfully has not been quantified for these segments of river.

b. Streamflow

Streamflow represents an important factor in the quality of habitat for aquatic life in the Cedar River, and particularly for the five anadromous fish species found there. The City's water supply and, to a lesser extent, hydroelectric power generating operations on the river can affect the total flow volume and the rate of change in those volumes. Although the extent of juvenile chinook rearing in the river is not as well described as for steelhead or coho, flows in the mainstem are likely an important consideration for newly emerged fry and are certainly important for chinook spawning and incubation.

Investigations and analyses used to support the development of an instream flow management regime for the Cedar River were directed and overseen by the Cedar River Instream Flow Committee (CRIFC) between 1987 and 1996, with the bulk of field investigations done by 1991. The CRIFC was composed of representatives from the Muckleshoot Indian Tribe, ACOE, WDFW, WDOE, FWS, NMFS, and the City of Seattle. This body of work addressed the various life history stages of four of the five species of anadromous salmonids in the Cedar River on a year round basis (see Tables 3.3-1 and 4.4-45 of the HCP). The CRIFC selected, directed and

oversaw all aspects of a comprehensive suite of studies including a full Instream Flow Incremental Method (IFIM) study. For example, in one aspect of the IFIM studies, the CRIFC instructed investigators to use habitat suitability criteria specifically developed for chinook and coho salmon and in Western Washington rivers. The IFIM study specifically assessed spawning, rearing, and passage requirements for chinook and steelhead, and spawning, spawning and rearing for coho, and spawning for sockeye (CES 1991).

The instream flow study results were used during 4 years of discussions with the members of the CRIFC to develop the instream flow management regime described in the March 14, 1997 Agreement in Principle to the Cedar River Habitat Conservation Plan and subsequently set forth in the HCP and IFA (Appendix 27 of the HCP).

Chinook begin spawning in the early fall, when stream flows in the Cedar are often at their lowest levels of the year. During the last half of September and early October, the amount of spawning habitat available to chinook can be limited by low stream flow. With the onset of autumn rain storms by mid- to late October, stream flows typically exceed the levels that provide the maximum amount of spawning habitat for chinook (CES 1991). In the Cedar, like many systems that support both sockeye and chinook salmon, spawning sockeye are present in large numbers during the entire time that chinook spawn. In most rivers, the larger chinook tend to spawn in deeper, swifter water, in larger substrate, and typically bury their eggs deeper than the smaller sockeye. While it is not presently considered a major controlling factor, the effects of the overlap between these two species on chinook spawning and incubation success in the Cedar River is not known.

Because chinook tend to spawn in deeper areas of rivers generally, their redds are perhaps somewhat less vulnerable to dewatering than those of other salmonids spawning in the Cedar. However, chinook redds can become vulnerable to dewatering if periods of very low flow occur during incubation (City 1998). Alevins of all salmonids are much more vulnerable to damage during dewatering than eggs (Becker et al. 1982, 1983, cited in the HCP).

There is little quantitative information on the effects of floods on chinook incubation survival in the Cedar River. Because chinook redds generally tend to be constructed in larger substrate and with deeper egg pockets than the redds of other species of salmon, they are perhaps somewhat less sensitive to scour during high flow events (Chapman et al. 1986, cited in the HCP). However, major flood events on the Cedar likely cause significant mortality of incubating chinook, based on studies of other rivers reported by Healey (1991). In the lower river, human development in the flood plain, diking, bank armoring, and flood management practices have reduced the width of the functional stream channel and reduced the river's ability to spread into the flood plain and dissipate energy during high water events (King County 1993). High flows are now confined within a relatively narrow corridor, which increases water velocity, sediment transport, and subsequently increases the frequency and degree of redd scour. This situation has

been further aggravated by the removal of forest cover and by increases in impervious surfaces in the lower watershed, which can increase the amplitude of high run-off events. Thoughtful water management practices can help to reduce flood peaks and frequency. However, in the Cedar River, water storage facilities only capture water from the upper 43 percent of the basin headwaters, leaving flows in the lower 57 percent unregulated. In addition, storage facilities in the upper basin have a relatively limited storage capacity. Although water management activities can help to reduce the magnitude of flood events and, to a limited degree, decrease the frequency of such events, the facilities are not adequate to eliminate the occurrence of major channel forming events.

During the period in which ocean-type chinook fry would be rearing in the Cedar River, stream flows are typically well above the levels that provide the maximum amount of rearing habitat, projected by weighted usable area calculations (CES 1991). Newly emerged chinook fry generally tend to occupy the areas near the margins of streams and are quite sensitive to stranding during rapid reductions in stream flow, especially at night (R.W. Beck and Associates 1989; Hunter 1992; all cited in the HCP). The potential for fry stranding under the current flow regime is uncertain, but is assumed to be minor. Fish that stay in the river prior to migrating downstream will be more vulnerable to stranding than fish that move directly downstream to the lake. The differential in survival of fry that rear in the river compared to those that rear in the lake is unknown but is a subject for further studies proposed by the City in the final HCP.

Chinook fry trapping results by WDFW in 1999 have not yet been finally reported, but preliminary results have been transmitted as a pers. com. from Dave Seiler, WDFW (1999). The majority of juvenile chinook emigrated from the Cedar River by mid-March. We estimate that this migration was 25%, 50%, and 75% complete by February 14, February 25, and March 14, respectively. There is no indication that chinook fry emigration in the Cedar River is consistently closely related to increases in flows. Observed daily increases in chinook fry emigration appear associated to some degree with lunar phases, e.g., new moons. Conclusive studies of chinook fry survival involving marked fish have not been done, but are the subject of further studies.

Chinook fry emigrated in two distinct time periods during the trapping season of Jan 22 to July 27. Fry were emigrating as soon as trapping begun, with an estimated migration of 5,217 before that date. Nightly emigrations ranged from 100 to over 1200 before the one-week peak emigration that began on Feb 13. During that week, an estimated 28 % of the early-season fry emigrated (or 22 % of the total fry emigration). Fry at that time average size was almost 40 mm and were caught by the traditional inclined-plane-type trap with efficiencies of 2 to 6 %. Daily flows during that week ranged from 820 down to 612 cfs. The period of emigration for the early season lasted through about mid-April, at which time daily flows had declined to less than 600 cfs. Cedar River flows during the early season fry trapping had gradually declined from 2,060 down to 996 cfs shortly before the peak week. Water withdrawals by the City had been fairly

constant over that same period, so the decline in flows was largely the result of natural conditions, which is typical for that time of year (USGS 1994).

On March 17, the screw-type trap began to operate and larger sized fry began to be trapped a few weeks later. Note that larger-sized chinook fry emigrating later in the season are usually not well sampled by the inclined-plane-type trap. A second period of emigration was observed from mid-May through mid-July, with a peak period in early June. An estimated 17 % of the total fry moved during this second period of 12 weeks, with related Cedar River flows declining from 760 to 460 cfs. Average fry sizes over that second period grew from 68 to 95 mm. Trap efficiencies averaged 23%.

A similar pattern of two separate emigration peaks was also observed from fry trapping in 1998. The early season was more protracted in 1998, early February through mid-March, while the second period also occurred from mid-May through early June (D. Seiler, WDFW, pers. comm. 1999).

The limited understanding of juvenile Cedar River chinook makes it difficult to predict the effects of flow on juvenile rearing and migration. If most juvenile chinook migrate to the lake immediately after emergence, successfully rear, and migrate to salt water, then higher stream flows during periods of emigration in the spring would be beneficial. However, if the dominant life history pattern is one in which the fish rear in the stream for longer periods prior to migrating to the lake and estuary, then high flows in the spring may force fry out of their preferred habitat too early for optimum survival. Preliminary information from fry trapping and habitat preference studies (R. Tabor and R. Peters, FWS, pers. comm. 1999) suggests that fry seek river margins and side channels to rear, but the limited availability of those complex habitats in the lower Cedar River may result in most fry emigrating early after those preferred habitat are filled with fry. The preliminary study results also suggest that while fry may preferentially use shallow areas and areas with complex cover, fry are widely distributed throughout the channel and make some use of the full range of available habitat types. Those fry that rear for several months emigrate later and their larger size likely confers survival advantages.

Another view of preliminary results of Lake Washington Ecological Studies suggests that the variation in chinook life-history strategies likely has associated a range of survival rates for each strategy. These assumed rates are presently unknown but in total may be beneficial to the overall survival of the species in the Lake WA basin (K. Fresh, WDFW, pers. com., 1999). By this logic, chinook fry that move into the lake from January through July may not be as much displaced from Cedar River habitats as seeking estuarine-like conditions favorable for short-term rearing. There is evidence that the lake littoral habitats indeed provides some measure of early rearing, based on the size of fry found along the shore by April (K. Fresh, WDFW, pers. com., 1999).

c. Disease

Fish disease is not thought to be a major factor affecting the survival of Cedar River chinook. However, a virus carried by sockeye salmon could potentially be of concern. Cedar River sockeye, like most sockeye, carry infectious IHNV the causative agent of the potentially fatal fish disease, infectious hematopoietic necrosis (IHN) virus. Chinook salmon are susceptible to IHN. However, the degree to which Cedar River chinook might be affected by the particular strain of IHNV present in Cedar River sockeye is uncertain, since this disease has not been observed in Cedar chinook (Wolf 1988; Hsu et al. 1986; all cited in the HCP).

d. Present Status in the Lake Washington Watershed

WDF et al. (1993) classified the status of Lake Washington chinook salmon as unresolved because of differing viewpoints of state and Tribal resource managers. In that same document, Muckleshoot Tribe comanagers assert that the Cedar fall chinook stock is “depressed.” Johnson et al. (1997, cited in the HCP) describe wild Puget Sound chinook as relatively stable from 1968 to 1990 with a sharp drop in abundance beginning in 1991 because of poor ocean survivals, habitat alterations, and harvest pressures. Recent trend analyses confirm the continuation of this decline and the State of Washington now classifies the demographic status of Lake Washington chinook as depressed (C. Smith, WDFW, pers. com., 1998, cited in the HCP). Note that MIT fisheries targeted on Cedar chinook have not occurred after 1993 (E. Warner, MIT, pers. com., 1999). A draft recovery plan for Lake WA chinook that has recently been developed by the Muckleshoot and Suquamish Tribes and WDFW provides more details of the present status of the chinook stocks and habitat conditions (MIT et al., 1999). The Cedar River is assumed to contain the largest portion of naturally spawning chinook numbers in Lake WA. The draft recovery plan identified a number of likely limiting factors in the Lake WA basin: altered flows, degraded water quality, altered sediment routing, degraded riparian forest functionality, loss of floodplains and wetlands, loss of lake littoral habitats, reduced access by fish, mixed-stock fisheries, interactions with hatchery stocks, and changes in numbers and distribution of competitors and predators. Another report by King County (1993) chronicled the specific conditions of aquatic and riparian habitats in the lower Cedar River below Landsburg Dam.

Between 1912 and 1917, the hydrology of the Cedar River and Lake Washington was dramatically altered when the Cedar was routed away from the Black River and Duamish estuary. Since that time, the Cedar has instead flowed into the lake, which was routed through the Ballard Locks to Salmon Bay. The effects on Cedar River chinook of moving the river into Lake Washington are difficult to ascertain but potentially quite profound. The lake provides a much different migration and rearing environment for recently emerged fry than the original river environment. Preliminary results of recent studies are beginning to reveal the extent to which Cedar chinook fry rear in the lake. Lake WA Ecological Studies conducted by the WDFW and MIT found little chinook rearing in the deep lake but some use of shoreline habitats (K. Fresh, WDFW, and E. Warner, MIT, pers. com., 1999). It is difficult to determine the quality of this

environment, which has been subjected to extensive shoreline development and is home to a host of introduced species that can prey on young chinook. The requirement for young chinook to migrate through Lake Washington could limit the productive capacity of the population.

The highly modified environment at the marine-freshwater interface downstream of the Ballard Locks poses an additional puzzle. This environment is much different than the natural estuary that was present at the mouth of the Duwamish River. Numerous sources as cited by Healey (1991) have reported on the importance of estuarine rearing for juvenile ocean-type chinook salmon. The behavior, growth, and survival of juvenile ocean-type juvenile chinook in the Ship Canal downstream of the Ballard Locks has not been well studied. However, it seems clear that this environment provides far less favorable conditions than the original estuary at the mouth of the Duwamish River. Chinook that emigrate as sub-yearlings in river systems located near the ocean typically rear for several months in shallow sloughs and estuarine margins (Healey 1991). These preferred features are largely absent in the Ship Canal and in Shilshoe Bay.

Chinook that currently spawn and rear in the 21.8 miles of mainstem river habitat downstream of the Landsburg Diversion Dam can be expected to colonize the habitat above Landsburg Dam to some extent if fish passage facilities are provided, based on introductions in other rivers, chinook spawners are expected to immigrate to accessible headwaters during periods of natural high flows (Winter, 1990, cited in USDI 1995). Access to the additional 12.4 miles of mainstem habitat and perhaps 4.6 miles of tributaries of upstream habitat would contribute substantial benefits to the population in the Cedar if other factors outside the watershed do not adversely affect their survival. Although the habitat in the Cedar River below Landsburg Dam has been modified by channel confinement structures, increased impervious surfaces, commercial and agricultural development and a general lack of riparian forest cover and large woody debris, it is still considered to provide some of the best salmonid habitat remaining in the basin (S. Foley, WDFW, 1997, pers. com., cited in the HCP). According to the recent comprehensive analysis by King County (1996), Adespite major habitat losses during the last 100 years of development, fish habitat in the Cedar River is still among the best located near the heavily urbanized areas of Puget Sound.@

6. Coho Salmon

Coho salmon are native to the Cedar River and may have been present in Lake Washington tributaries prior to the turn of the twentieth century. However, it is unclear to what extent anadromy existed in Lake Washington and its tributaries as a result of the Lake's outlet connection to the Black River. The response of the original population of coho salmon in the Cedar River to the rather dramatic changes in the hydrology of the Lake Watershed in the early twentieth century is not known. It is not clear to what degree the present Cedar River coho population is derived from the original population that eventually found their way back to the

river. Nor is it known if strays from other nearby systems or from past plantings of hatchery fish have contributed significantly to the present day population. Regardless of the source, a naturally reproducing population of coho salmon has evidently persisted in this altered environment.

There are a number of factors that can potentially affect the survival of Lake Washington coho salmon at various stages of their life history. These factors occur in both the fresh water and marine environment. Factors in fresh water include habitat loss and degradation, predation, droughts, floods (NMFS 1995), and injury or mortality at the Ballard Locks (Goetz et al. 1997, cited in the HCP). Factors in the marine environment include predation, unfavorable ocean conditions, and harvest (NMFS 1995). Although sport and Tribal harvests in Lake Washington are typically well controlled to ensure an adequate escapement, there is little control over harvest of coho in Puget Sound and Canada.

Since 1916, the Landsburg Diversion Dam and associated pipeline crossing has blocked the migration of coho to approximately 17 miles of formerly accessible mainstem and associated tributary habitat within the Cedar River Municipal Watershed. In its original configuration, the Cedar River and its tributaries likely formed ideal habitat for coho salmon, e.g., many shallow river margins with complex cover and some side-channels. It is likely that coho salmon were present in quite substantial numbers. Coho salmon currently spawn in the Cedar River downstream of Landsburg Dam every year. If provided with passage over the diversion dam, these fish would likely colonize the habitat above Landsburg Dam to an unknown degree, but based on introductions in other rivers, coho spawners are expected to immigrate to accessible headwaters (Winter, 1990, cited in USDI 1995).

a. Streamflow

It is believed that redd scour during flood events is a dominant factor controlling the survival of species such as sockeye that spawn in the mainstem Cedar River (Thorne and Ames 1987, cited in the HCP). Because coho salmon spawn principally in smaller streams and tributaries to the Cedar, mainstem redd scour does not substantially affect coho production. However, urbanization below Landsburg Dam has had substantial impacts in smaller tributaries entering the Cedar River. These impacts include sedimentation resulting from urban development in upstream plateau areas and reduction in the complexity of stream channels, riparian areas, and wetlands (King County 1993). Other areas have been modified to pass higher peak flows during storm run-off and have resulted in substantial bed and bank scour and channel shifting (WDF et al. 1993; NMFS 1995). These factors have substantially altered spawning gravel quality and stability and calm water areas used by juveniles for refuge during flood events.

Low summer base-flow conditions can have substantial effects on species like coho that rear in the river for an extended period. During low flow periods, juvenile fish can be stressed by factors such as high water temperatures and crowding, which in turn can increase rates of

disease, competition, and predation (Zillges 1977; Baranski 1989, all cited in the HCP). According to an extensive, collaborative instream flow study (PHABSIM) conducted by CES (1991), flows in the Cedar River typically exceed levels required to produce maximum coho rearing habitat except from mid-July to mid-September. During this period, flows typically provide approximately 95 percent of the maximum rearing habitat for juvenile coho (CES 1991). Although these summer base flows provide substantial levels of habitat, they are typically lower than pre-diversion flows (King County 1993). These reduced flows, in addition to extensive riparian clearing, increased impervious surfaces, reduced amounts of large woody debris, increased sedimentation, and channel confinement, have reduced channel complexity and pool habitat and caused a decline in the quality of coho summer rearing habitat in the Cedar River basin downstream of Landsburg Diversion Dam. Urban development in the Lake Washington Basin has also changed the structure of fish communities. The typical native Puget Sound fish community, with a diverse assemblage of salmonids and non-salmonids, has been replaced with a less diverse species assemblage in which cutthroat trout predominate (Scott et al. 1986, cited in the HCP).

b. Present Status in the Lake Washington Watershed

Coho populations in the Lake Washington Basin have undergone significant declines in recent years. Coho escapement peaked at over 30,000 fish in 1970, but declined to less than 2,000 fish in 1992 and perhaps only 200 in 1999 (Fresh 1994; King County 1993; E. Warner, MIT, pers. com., 1999). The desired escapement for Lake Washington is 15,000 fish, which has not been achieved since 1979. Based on available habitat, coho returns to the Cedar River are usually 12-15 percent of the total return to the Lake Washington Basin (King County 1993). Therefore, recent returns of approximately 200 to 2,000 coho represent a run of only 26 to 270 fish to the Cedar River. Although the status of Cedar River coho salmon was determined to be healthy in 1992 (WDFW et al. 1993), this assessment acknowledged that the stock would fall into the depressed classification if future returns similar to those in 1991 were observed. As a result of the continuation of the downward population trend (Fresh 1994; King County 1993), coho salmon are now considered depressed in the Cedar River and elsewhere in the Lake Washington Basin.

With continued low returns of coho salmon over the past 7 years, harvests in the Lake Washington Basin and the Cedar River have continued to decline. Recreational fishing on the Cedar River is currently closed and is not expected to fully reopen until substantial improvements in returns of all anadromous salmonids are reported. The current outlook for the population is one of continued decline.

Similar to other salmonids in the Lake Washington watershed, coho must migrate through the facilities at the Ballard Locks to reach Puget Sound. Some of the pathways through the locks can injure or kill a portion of the juvenile fish migrating through the facility. The degree to which

migrants are injured has not been well quantified (F. Goetz, ACOE, 1998, pers. com., cited in the HCP). In an effort to determine the extent of the problem and identify improvements, the ACOE is currently analyzing the factors affecting the survival of out-migrating salmonids and is beginning to develop measures to improve downstream migrant survival (Goetz et al. 1997, cited in the HCP).

Coho currently spawn and rear in selected parts of the 21.8 miles of mainstem river habitat and an unknown amount of tributary habitat downstream of the Landsburg Diversion Dam and can be expected to colonize the habitat above Landsburg Dam if fish passage facilities are provided. Access to the additional 12.4 miles of mainstem habitat and 4.6 miles of tributaries of upstream habitat would contribute substantial benefits to the population in the Cedar if other factors outside the watershed do not adversely affect their survival. Although the habitat in the Cedar River below Landsburg Dam has been modified by channel confinement structures, increased impervious surfaces, removal of woody material, commercial and agricultural development and a general lack of riparian forest cover and large woody debris, it is still considered to provide some of the best salmonid habitat remaining in the basin (S. Foley, WDFW, pers. com., 1997, cited in the HCP). According to the recent comprehensive analysis by King County (1996), Adespite major habitat losses during the last 100 years of development, fish habitat in the Cedar River is still among the best located near the heavily urbanized areas of Puget Sound.®

7. Steelhead

In 1917, the Lake Washington ship canal was completed and the outlet of Lake Washington was rerouted through Lake Union, down to the Ballard Locks and into Salmon Bay. As a result of this project, the elevation of Lake Washington dropped approximately 8.8 ft and the Black River was dewatered. After the change in lake elevation, the Cedar River was re-routed into the south end of Lake Washington, cutting off the normal migration corridor for Cedar River anadromous fish. The response of the original population of steelhead trout to these alterations is not known, and information concerning the role of the lake in juvenile and adult life history phases is lacking.

In the early 1900s, construction of Landsburg Dam and associated pipeline crossing was completed without fish passage facilities, blocking access to approximately 17 miles of previously productive anadromous fish habitat. By the beginning of the twentieth century the stream habitat between Cedar Falls and Landsburg Dam had been impacted by extensive timber harvesting. Today this habitat has largely recovered from the effects of logging (City 1998), and its potential to provide excellent habitat for salmonids is indicated by the presence of a robust population of resident rainbow trout. There are relatively large inputs of high quality ground water throughout the Landsburg Dam-Cedar Falls reach (City et al., 1999a). According to the Watershed Analysis (summarized in Appendix 16), erosion and sedimentation is largely in

balance with the other natural processes, and riparian zones are largely intact, with much of the stream channel shaded by mature stands of coniferous trees.

Steelhead trout currently spawn and rear in the 21.8 miles of mainstem river habitat downstream of the Landsburg Dam and can be expected to colonize the habitat above Landsburg Dam if fish passage facilities are provided. Access to the upstream habitat would contribute substantial benefits to the population if other factors outside the watershed do not adversely affect their survival. Although the habitat in the Cedar River below Landsburg Dam has been modified by channel confinement structures, increased impervious surfaces, removal of woody material, commercial and agricultural development, and a general lack of riparian forest cover and large woody debris, it is still considered to provide the best steelhead habitat in the basin (S. Foley, WDFW, 1997, pers. com.). According to the recent comprehensive analysis by King County (1996), Adespite major habitat losses during the last 100 years of development, fish habitat in the Cedar River is still among the best located near the heavily urbanized areas of Puget Sound.®

a. Streamflow

Streamflow represents a very important factor in the quality of habitat for aquatic life in the Cedar River, particularly for the five anadromous fish species found there. The City's water supply and hydroelectric operations on the river can affect the total flow volume and the rate of change in those volumes. Flows in the mainstem of the Cedar River are an important consideration for protecting steelhead during spawning, incubation, and rearing (CES 1991).

Steelhead typically spawn at a time when the hydrograph is on a decreasing trend (river water levels are decreasing), which can potentially make their redds vulnerable to dewatering. Particularly during years with high spring stream flows, steelhead are able to access spawning habitat that may later become dewatered as instream flows decrease with the declining snow melt and rainfall in June and July (CES 1991). To address this potential problem, a cooperative effort between WDFW and the City was established in 1995 to monitor steelhead redds to determine the relationship between instream flows and impacts to incubating and emerging steelhead. The initial results of the ongoing monitoring program indicate that substantial redd dewatering can occur in years with unusually high spring freshet flows if measures are not taken to adaptively manage instream flows to protect shallow, vulnerable redds. The probability of redd dewatering increases substantially in July when the majority of steelhead remaining in their redds have hatched to become alevins. Alevins are much more vulnerable to damage by dewatering than eggs (Becker et al. 1982, cited in the HCP).

Instream flow levels in the Cedar River can also impact incubating and emerging steelhead by scouring redds during spring freshet events in March and April. There is very little quantitative data on the effects of floods on steelhead incubation survival in the Cedar River. Because steelhead spawn on a descending hydrograph, they are generally less vulnerable to redd scour

than their Pacific salmon relatives that spawn and incubate during fall and winter when the hydrograph is increasing and the probability of major flood events is much higher. Nevertheless, significant Cedar River flood events have occurred in March and April, possibly causing mortality to incubating and emerging steelhead. In addition, flood plain development, levees, bank armoring, and flood management practices have reduced the width of the functional stream channel and reduced the river's ability to interact with the natural flood plain to dissipate energy during flood events (King County 1993). High flows are now confined within a relatively narrow corridor, which increases water velocity and sediment transport, and subsequently increases the frequency and intensity of flood scour. This situation has been further aggravated by the removal of forest cover and large woody debris, and increases in the impervious surface area in the lower watershed.

Thoughtful water management practices can help to reduce flood peaks and frequency. However, water storage facilities only capture water from the upper 43 percent of the Cedar River Basin, leaving inputs from the lower 57 percent of the watershed unregulated. In addition, storage facilities in the upper basin have a relatively limited storage capacity. Although water management activities can help to reduce the magnitude of flood events and, to a limited degree, decrease the frequency of such events, the facilities are not adequate to eliminate the occurrence of major channel forming events.

b. Present Status in the Lake Washington Watershed

Steelhead trout currently spawn and rear in the 21.8 miles of mainstem river habitat downstream of the Landsburg Diversion Dam and can be expected to colonize the habitat above Landsburg Dam if fish passage facilities are provided. Access to the additional 12.4 miles of mainstem habitat and 4.6 miles of tributaries of upstream habitat would contribute substantial benefits to the population in the Cedar if other factors outside the watershed do not adversely affect their survival. Although the habitat in the Cedar River below Landsburg Dam has been modified by channel confinement structures, increased impervious surfaces, commercial and agricultural development and a general lack of riparian forest cover and large woody debris, it is still considered to provide some of the best salmonid habitat remaining in the basin (Foley, S., WDFW, 1997, pers. com., cited in the HCP).

In addition to the hydrological alterations associated with rerouting the Cedar River into Lake Washington, there are a number of other factors that potentially influence the survival of Cedar River steelhead trout. These factors include predation by sea lions at the Ballard Locks; degradation of stream habitat from land and water management practices; predation by native and exotic species in the lower Cedar and Lake Washington, injury to juvenile fish exiting the lake via the Ballard Locks; excessive recreational harvest; illegal fishing practices (poaching); droughts; floods; and unfavorable ocean conditions.

One of the major factors contributing to the decline of steelhead in the Cedar River is predation from sea lions at the Ballard Locks. The precipitous decline experienced during the 1990s coincides with the arrival of feeding sea lions at the locks in the 1980s. Recent studies have shown that sea lions once consumed an annual average of 60 percent of the adult steelhead migrating through the locks (Fraker 1993, cited in the HCP). As a result of this impact, there has been an exemption from the Marine Mammals Act that allows problem sea lions at the Ballard Locks to be removed or euthanized. In 1996, three problem sea lions were captured and moved to Sea World in an attempt to reduce the associated predation mortality at the locks.

c. Rainbow Trout in the Municipal Watershed

In addition to the wild population of winter steelhead found below Landsburg Diversion Dam, there are also two populations of resident rainbow trout above the diversion (City 1998). The first population occurs between Landsburg and Cedar Falls, the historic natural barrier to anadromous fishes. The second population occurs in Chester Morse Lake and its tributaries. Genetic analysis of these populations suggests that rainbow trout in Chester Morse Lake were derived from a hatchery planting, however not necessarily from one of the strains currently maintained at the WDFW hatcheries. In contrast, the rainbow trout population between Landsburg and Cedar Falls is more similar to Cedar River and Puget Sound steelhead than to Chester Morse rainbow trout. However, the rainbow trout population above Landsburg Dam also contains alleles from hatchery rainbow trout. Because these alleles are spread throughout the population, the hypothesis that there has been interbreeding between hatchery-originated and wild fish in this reach is supported.

Because of the introgression with non-native, hatchery-originated rainbow trout, neither of the resident rainbow populations in the municipal watershed are considered suitable for artificial supplementation of steelhead in the Lake Washington Basin (S. Phelps, WDFW, 1998, pers. com., cited in the HCP).

8. Coastal Cutthroat Trout

The City's water diversion structures prevent coastal cutthroat from potentially accessing stream habitat in the watershed above the Landsburg Dam. Prior to construction of the dam, returning adults would have been able to access 17 stream miles in the mainstem Cedar River and tributaries between the naturally impassable Cedar Falls and the Landsburg Dam location (City 1998). Currently, only the Walsh Lake subbasin in the watershed is potentially accessible to coastal anadromous cutthroat because this subbasin is connected to the Cedar River at a location below the Landsburg diversion dam. Although coastal cutthroat trout are widespread in this subbasin, it is unknown if anadromous individuals use this habitat.

Resident cutthroat trout are also widely distributed in many of the tributaries downstream of Cedar Falls. They have not been found in the upper municipal watershed. Potential habitats for this species in the watershed include well-shaded headwater streams with areas of low-gradient gravels suitable for redd construction. Instream conditions in many streams are considered suitable for this species (City 1998).

a. Streamflows

The IFIM study did not specifically address cutthroat. The relatively small size, occurrence mainly in headwater streams, and overlap in spawning times with winter and spring high flows are all factors that suggest this species is unlikely to be flow-limited in the Cedar River.

b. Present Status in the Lake Washington Watershed

In the Lake Washington Basin, the coastal cutthroat trout is the only species of cutthroat trout known to naturally occur and is present in both resident and anadromous forms. The population of coastal cutthroat in the Lake Washington Basin is most likely a native stock, although coastal cutthroat were stocked in numerous Lake Washington streams as early as 1895 by the U.S. Bureau of Fisheries (Crawford 1979, cited in the HCP). Between 1932 and 1946, cutthroat trout brood stock were also obtained from several Lake Washington tributaries (Crawford 1979, cited in the HCP). Hatchery programs for coastal cutthroat trout are no longer in operation in Puget Sound (Leider 1995, cited in the HCP).

In recent years, resident cutthroat trout have increased in abundance in the Lake Washington Basin (Fresh 1994, cited in the HCP). Widespread urbanization around Lake Washington has created more marginal conditions that cutthroat trout are able to use more successfully than other trout and salmon. (Ludwa et al. 1997, Scott et al. 1986; all cited in the HCP). Notably, in areas of co-occurrence with other salmonid species, cutthroat trout appear to take a subdominant role (Johnson et al. 1994, cited in the HCP); therefore, apparent population increases in the Lake Washington Basin may reflect increased availability of marginal habitats, from which other salmonid species have disappeared as a result of habitat degradation. Cutthroat trout are also the primary fish caught recreationally, as documented by recent creel surveys conducted by the WDFW, although some of these fish are a cutthroat trout/rainbow trout hybrid (R. Pfeifer, WDFW, 1998, pers. com., cited in the HCP). Data on the number of adult coastal cutthroat trout entering the basin via the fish ladder at the Ballard Locks are unavailable.

9. Sockeye salmon

By 1917, the hydrologic pattern of the Lake Washington Basin had been dramatically altered with the rerouting of the Cedar River directly into Lake Washington, the creation of a new outlet via the Ballard Locks, and the lowering of the mean water level in the lake by nearly 9 ft (Chrastowski 1983, cited in the HCP). While this alteration likely had substantial negative effects on some salmonid species, it created conditions under which anadromous sockeye salmon could flourish in the Cedar River. In contrast to the other anadromous salmonids in the watershed that rear as juveniles for extended periods in stream habitats (steelhead trout, coho salmon, and chinook salmon), sockeye move downstream immediately after emergence from the gravel and begin to take advantage of the comparatively vast rearing areas and abundant food resources offered by the lake.

In this new hydrologic configuration, sockeye fry produced in the Cedar River were provided with a very direct pathway to the lake and out-migrating smolts were provided with direct access to salt water. In only 30 years, the transplanted Baker River sockeye grew into a robust, naturally reproducing population from relatively small initial plantings. This rapid population growth over a limited number of years and the presence of substantial numbers of potentially native sockeye in the north Lake Washington tributaries are perhaps good indicators of the generally favorable environment for anadromous sockeye salmon provided by Lake Washington. However, many other effects of human settlement and development on this generally benign environment have also reduced the system's resilience and capacity to support anadromous fish, including sockeye.

Today, naturally reproducing sockeye are established in the lower river below Landsburg and every year substantial numbers of adult fish migrate upstream as far as the migration barriers at the pipeline crossing and Landsburg. Exclusion from the habitat upstream of the diversion limits the productive capacity and resiliency of the Cedar River sockeye population.

a. Stream Flow

Sockeye begin spawning in the early fall when stream flows often recede to their lowest levels of the year. During the last half of September and early October, the amount of spawning habitat available to sockeye can be limited by low stream flow. By mid- to late October, stream flow typically exceeds the levels that provide the maximum amount of spawning habitat for sockeye (CES 1991).

In the Cedar River, redd scour during flood events is thought to be a dominant factor controlling the survival of incubating eggs and alevins (Thorne and Ames 1987, cited in the HCP). Floodplain development, diking, bank armoring, and flood management practices have reduced the width of the functional stream channel and reduced the river's ability to spread into the flood plain and dissipate energy during high water events (City 1998). High flows are now confined

within a relatively narrow corridor that has had the effects of increasing water velocity, transporting sediment, and subsequently increasing the frequency and degree of redd scour. Sockeye redd scour starts to occur when streamflow, as measured near the mouth of the river in Renton, exceeds approximately 1800-2000 cfs. Scour rates increase quite rapidly as flows increase beyond this level (CES 1991; Seiler and Kishimoto 1997b, cited in the HCP). Sockeye redds located near the stream margins appear to be somewhat less vulnerable to scour than redds located in the center of the channel. However, the amount of spawning habitat available along the stream margins is relatively limited and generally available to spawning fish only at relatively high flow levels that exclude fish from much of the spawning habitat in mid-channel areas (CES 1991).

Juvenile sockeye trapping information suggests that newly emerged sockeye fry can experience significant mortality during their 1-2-day migration downstream to Lake Washington (Seiler 1994, 1995; Seiler and Kishimoto 1996, 1997a; all cited in the HCP; and D. Seiler, WDFW, pers. com., 1999). The survival of emigrating fry appears to be higher during periods of elevated flows, and survival at similar flow levels can vary significantly from year to year. Other factors that may affect out-migrant survival include water clarity, temperature, and light intensity (Burgner 1991). One of the key mechanisms causing mortality during emigration to the lake is hypothesized to be predation by sculpin (Tabor and Chan 1996, cited in the HCP). Sculpin population size may in turn be partially controlled by peak winter flood events.

b. Juvenile Sockeye Survival in Lake Washington

In recent years, the survival of juvenile sockeye during their residence in Lake Washington has been assumed to be lower than in the past. Preliminary results of unpublished studies suggests that assumptions about low survivals may not necessarily be valid (E. Warner, MIT, pers. com., 1999). The factors causing this assumed poor survival are unclear, and a number of hypotheses are being tested as part of the Lake Washington Ecological Studies (City 1998). The hypotheses may be grouped into two categories: (1) those that consider the effects of predators on juvenile salmon, and (2) those that consider trophic relationships and the carrying capacity of Lake Washington. There are a number of native and exotic predators that prey on juvenile salmon. Study results to understand the magnitude of predation, especially in offshore areas where young sockeye spend most of their lives, have not yet been published, but preliminary results found that cutthroat and sculpins are major predators on sockeye fry (E. Warner, MIT, pers. com., 1999). Sockeye smolts leaving Lake Washington are consistently among the largest in the world (Burgner 1991), which suggests that food may be quite abundant. However, recent bioenergetic modeling exercises indicate that, in years when planktivorous fish are abundant and zooplankton populations are relatively sparse, newly emerged sockeye fry that enter the lake during the early period of their migration could experience difficulty in securing an adequate food supply (Beauchamp 1996, cited in the HCP).

All sockeye smolts must migrate through the facilities at the Ballard Locks to reach the ocean. There are approximately five pathways for juvenile sockeye through the Ballard Locks. Under certain operating regimes, some of these pathways can injure or kill a portion of the fish migrating through the system. The ACOE, in cooperation with Lake Washington Ecological Studies program, is currently investigating the factors affecting the survival of out-migrating salmonids as they pass through the locks and testing methods to provide better downstream passage conditions (Goetz et al. 1997, cited in the HCP).

c. Present Status in the Lake Washington Watershed

A number of factors can potentially affect the survival of Lake Washington sockeye salmon at various stages of their life history, including habitat loss and degradation resulting from a variety of land and water management practices (King County 1993); scour of incubating eggs and alevins during floods (Seiler and Kishimoto 1997, cited in the HCP); predation by native and exotic fish in the Cedar River and Lake Washington (Beauchamp 1993; Tabor and Chan 1996; all cited in the HCP); food supplies in the lake (Beauchamp 1996, cited in the HCP); injury to smolts leaving the Lake via the Ballard Locks (Goetz et al. 1997, cited in the HCP); droughts; and unfavorable ocean conditions. As a result of the population's early run timing, harvest rates for Lake Washington sockeye are typically very low in the marine environment. Occasionally, early season harvests targeting up-river stocks of Fraser River Sockeye are permitted in north Puget Sound. This fishery must be carefully controlled to prevent unintentional over-harvest of Lake Washington sockeye (E. Warner, MIT, pers. com., 1998; cited in the HCP). Although sport and Tribal harvests in Lake Washington are typically well controlled to ensure that adequate numbers of fish return to streams to spawn, Cedar River sockeye can be vulnerable to over-harvest, as demonstrated during the 1996 season when insufficient numbers of fish returned to meet escapement goals in the Cedar after substantial sport and Tribal harvests in the lake.

Clearly, there are a number of ways in which human activities have had impacts on sockeye in the Lake Washington Basin. But perhaps the most profound human impact on the aquatic ecosystem, the alteration of the basin's hydrologic pattern (Chrzastowski 1983, cited in the HCP), has been beneficial for anadromous sockeye salmon.

After building to relatively robust levels in the 1960s and 1970s, the Lake Washington Sockeye population has experienced a period of significant decline. The mean spawner return ratio during the last 11 brood years for which full return data is available is 0.79. This means that, on average, for each 100 fish that successfully spawns in the basin, only 79 fish have returned to spawn in the subsequent generation. Since record keeping began in 1967, the escapement goal for the system of 350,000 adult fish has been met or has been exceeded four times. Since the escapement goal was last achieved in 1988, the mean run size has been approximately 135,000 fish (WDFW 1997e, cited in the HCP). WDF et al. (1993) classify the Lake Washington sockeye population as depressed in the Cedar River and elsewhere in the basin.

Sockeye harvest opportunities have recently declined in frequency. In 8 of the 22 years between 1967 and 1988, Tribal and sport fishers harvested substantial numbers of sockeye in Lake Washington. Since 1988, Tribal and sport harvests have been conducted in Lake Washington only in 1996 (WDFW 1997e, cited in the HCP). Although the 1996 return of approximately 450,000 adult fish indicates that the system has retained some potential to produce significant numbers of fish, the general trend in the sockeye population remains one of relatively steep decline.

V. ELEMENTS OF THE HABITAT CONSERVATION PLAN

A. Overall Goal of the HCP

The overall goal of the HCP is to implement conservation strategies designed to protect and restore habitats of all species of concern that may be affected by the facilities and operations of the City of Seattle on the Cedar River, while allowing the City to continue to provide high quality drinking water and reasonably priced electricity to the region.

The City's HCP has four major components: (1) management of instream flows to provide habitat for anadromous fish; (2) mitigation for the blockage to anadromous fish at the Landsburg Diversion Dam, including provision of upstream passage for four of the five species currently blocked; (3) management of the municipal watershed to protect and restore aquatic, riparian, and late-successional and old-growth habitats; and (4) research and monitoring to address important uncertainties; to evaluate effectiveness of mitigation, compliance with the plan, and trends in habitats and key species; and to provide for adaptive management.

B. Proposed Conservation Measures to Avoid, Minimize, and Mitigate Take.

The first three components of the HCP incorporate a variety of measures that collectively contribute to protection and restoration of the species and habitats addressed by this HCP. These measures are designed to control, avoid, or minimize impacts from City operations, to preserve habitat elements that are relatively undisturbed, and to restore the quality and functionality of some other habitats that have been previously disturbed.

1. Watershed Management Mitigation and Conservation Strategies

The HCP's watershed management mitigation and conservation strategies are designed to protect

and contribute to the restoration of the habitats of at-risk species, and to contribute to the restoration of ecological and physical processes and functions that create and maintain key habitats and habitat features. A watershed-level analysis was conducted in 1995 in order to prepare specific prescriptions for protecting sensitive sites from potential cumulative impacts of timber harvest and related road operations (Appendix 16 of the HCP).

The proposed mitigation represents a landscape approach to watershed management that includes: managing the entire watershed essentially as a very large ecological reserve; no commercial timber harvest; repair of roads to control potential erosion and restore fish passage; and a substantial commitment to habitat restoration. These measures were developed collectively to protect water quality, restore tributary fish passage, contribute substantially to regional conservation of fish and wildlife, mitigate for potential adverse impacts of City management activities, and foster natural biological diversity.

The HCP also includes management actions designed to improve and help restore aquatic, riparian, and upland forest habitats within the municipal watershed. Stream bank stabilization projects, placement of large woody debris (LWD), a stream bank revegetation program, and a program of restoration planting, restoration thinning, and ecological thinning in riparian areas is designed to (1) restore natural aquatic and riparian ecosystem functioning and (2) accelerate the development of mature or late-successional characteristics in younger second-growth forests in riparian areas. HCP operations of thinning and planting, and associated road use, include the following: (1) restoration planting of about 1,400 acres; (2) restoration thinning of about 11,000 acres; (3) ecological thinning of about 2,000 acres; (4) instream habitat restoration projects; (5) removal of approximately 240 miles of road over the first 20 years (with the potential for additional road removal later); (6) maintenance of about 520 miles of road per year at the start of the HCP, diminishing as roads are removed over time to about 380 miles per year at year 20; (7) improvement of about 4 to 10 miles of road per year (occasionally more in some years); and (8) routine road use.

2. Minimizing and Mitigating the Effects of the Anadromous Fish Barriers at the Landsburg Diversion Dam

The anadromous fish conservation strategies are designed to mitigate for the blockage to fish passage created by the Landsburg Dam. The anadromous fish conservation strategies in this HCP are designed to complement other regional efforts to protect and restore declining stocks in the Lake Washington Basin (City 1998). The intent is to implement biologically sound solutions that: (1) contribute to the recovery and persistence of healthy, harvestable runs of anadromous fish in the Cedar River and Lake Washington Basin; (2) have a high likelihood of success; and (3) maintain a safe, high quality drinking water supply.

The six primary objectives for the conservation of anadromous fish in the Cedar River were

developed by the multi-agency Cedar River Policy and Technical committees and the City.

- a. Implement biologically sound, short- and long-term solutions that help provide for the recovery and persistence of well-adapted, genetically diverse, healthy, harvestable runs of sockeye, coho, and chinook salmon and steelhead trout in the Cedar River without negatively affecting other naturally reproducing stocks within the Lake Washington Basin.
- b. Maintain a safe, high quality drinking water supply.
- c. Implement restoration alternatives that have a high likelihood for success and that provide substantial value for target resources.
- d. Provide fish passage over the Landsburg Diversion Dam, consistent with water quality protection, that is coordinated with run recovery, biological need, water supply operations, and facility maintenance requirements.
- e. Coordinate with and support other compatible fish rehabilitation activities to help realize the full benefits offered by aquatic resource conservation efforts in the Lake Washington Basin.
- f. Design restoration measures in a manner that satisfies the City's mitigation objectives for the fish migration blockage created by the Landsburg Dam, as defined by state and federal law and pursuant to City ordinance and initiatives.

The Cedar River Anadromous Fish Committee (CRAFC) will advise and consult with the City to incorporate the best available science in the implementation of fisheries measures. These measures are intended to benefit the fishery resources of the Cedar River by protecting, improving, and increasing fish production and available habitat. The City, in cooperation with the other parties, will conduct studies of the fish populations and monitor the fisheries measures, then act on the results, according to the HCP conservation measures, to manage anadromous fish mitigation in an adaptive fashion.

Anadromous salmonids have not been allowed to immigrate into the protected watershed above Landsburg Dam in nearly a century. The HCP will provide passage for four of the five species of anadromous salmonids into the protected watershed, which is significant regionally as high quality refuge habitat. Downstream passage of juvenile fish at Landsburg Dam will be protected by a new set of screens. Because of risks to public health, and the desire to maintain water treatment without filtering, the City cannot allow passage of the potentially large numbers of sockeye salmon above the raw water intake. In lieu of passage for that species, the City will commit to a combination of artificial propagation and habitat restoration for sockeye, with extensive monitoring and appropriate adaptive management provisions to reduce risks to all naturally spawning salmonids in the Lake WA basin.

The HCP measures address chinook, coho, and steelhead through: (1) construction of fish

passage and protection facilities at Landsburg Diversion Dam to allow the three species access to historic habitat; (2) water quality protection, and habitat protection and restoration measures which will improve habitat conditions in the municipal watershed; (3) funding for interim mitigation before the fish passage facilities are built, which may include funding for studies or emergency supplementation; (4) provision of the HCP instream flow management regime to improve habitat conditions in the lower river; (5) funding for habitat protection and restoration in the lower Cedar River, downstream of the municipal watershed; (6) funding for projects at the Ballard Locks designed to increase survival of emigrating smolts; and (7) monitoring and research.

The provision of fish passage and protection facilities at the Landsburg Diversion Dam is of particular importance to chinook, coho, steelhead, and cutthroat. These facilities will allow these four anadromous species to recolonize their formerly occupied habitat upstream of the Landsburg Diversion Dam. Because a significant period of time will be required to complete final design, permitting, and construction of long-term mitigation facilities, the City will begin providing interim conservation measures for chinook, coho, and steelhead as directed by the parties to the Landsburg Mitigation Agreement, with advice from CRAFC, immediately in HCP year 1 in an effort to help halt the decline of anadromous fish populations in the basin.

Fish passage facilities are expected to be completed by the end of HCP year 3, subject to the City's ability to gain the necessary permits and complete the SEPA review process. The City will provide up to \$90,000 per year to fund interim mitigation measures until all fish passage facilities are in operation. These funds would be used to: (1) fund the implementation of life history, genetic, demographic, and/or ecological studies to fill critical information gaps facilitating efforts to protect and restore habitat in the Lake Washington Basin; (2) implement emergency supplemental production programs designed to help sustain and rebuild the populations in a manner that helps ensure their long-term reproductive fitness and capacity to adapt to changing environmental conditions (a population support measure); and/or (3) fund other measures deemed appropriate by the parties to the LMA to achieve the objectives of the LMA.

Upstream and downstream fish-passage facilities and new intake screens at the Landsburg Diversion Dam will be constructed to provide passage and protection for coho salmon, chinook salmon, and steelhead and coastal cutthroat trout. These facilities are designed to open 12.4 miles of the mainstem Cedar River and 4.9 miles of associated tributary streams (Rock Creek, Taylor Creek, William Creek, and Steele Creek) in the protected municipal watershed for the spawning and rearing of these four anadromous fish species.

The lower Cedar River downstream of the municipal watershed has been impacted by urban development, channel modifications, riparian zone disturbance, and peak flow management practices (King County 1996). Mainstem and side-channel habitat quantity and quality have been reduced substantially in the lower river when compared to pre-development conditions. The HCP provides \$4.6 million in funding to implement habitat protection and restoration projects in the river basin downstream of the City's ownership boundary in the Lower Cedar

River. If matched by contributions from King County, the HCP will provide an additional \$270,000 for habitat restoration in the Walsh Lake sub-basin both within and downstream of the City's ownership boundary.

3. Instream Flow Management Strategy

a. Rationale

The primary purpose of the instream flow conservation strategy is to provide stream flows in the Cedar River downstream of Morse Lake that will help ensure the presence of suitable aquatic habitat, based on weighted usable area projections, throughout 34.2 miles of the mainstem river between Lower Cedar Falls and Lake Washington. This reach of river constitutes the entire natural historic range of anadromous fish in the Cedar River. Five anadromous fish species, (i.e., chinook, coho, and sockeye salmon and steelhead and cutthroat trout) presently occupy the lower 21.8 miles of the mainstem. The HCP provides for the reintroduction of chinook, coho, steelhead and anadromous cutthroat into the additional 12.4 miles of mainstem and associated tributary habitat upstream of the Landsburg Diversion Dam.

The Cedar River basin is the largest sub-basin in the Lake Washington watershed and provides approximately 50% of the total annual flow into the lake. Conservation measures in the municipal watershed, which comprises 2/3 of the Cedar River sub-basin, are expected to deliver substantial water quality benefits to aquatic habitat within the municipal watershed, in the mainstem of the river downstream of the municipal watershed, and in Lake Washington.

Water quality and quantity are both important components of aquatic habitat. The instream flow conservation strategy deals primarily with water quantity. The HCP addresses water quality protection through the watershed management prescriptions described in Section 4.2. Water quality is generally excellent in the 12.5 mile reach of the mainstem within the City's ownership boundary due to relatively large inputs of high quality groundwater and because much of this portion of the basin has recovered substantially after being intensively logged early in the twentieth century. Although many factors downstream of the City's ownership boundary pose threats to water quality in the lower reaches of the river, these threats are partially offset by the relatively large inputs of high quality water from the municipal watershed. In addition, the factors that threaten water quality are being addressed to various degrees through the implementation of King County's Cedar River Basin Plan.

The HCP views the four anadromous fish species as keystone species for the aquatic habitat in the Cedar River downstream of Morse Lake. These species have relatively stringent freshwater habitat requirements and are present in at least one, and typically more, life history stages throughout the year. Biophysical processes and anthropogenic activities throughout the area encompassed by the natural hydrographic boundary of the Cedar River Basin directly affect the

quantity and quality of anadromous fish habitat in the Cedar River. The City does not have control over activities in the basin outside its ownership boundary, nor on conditions in the marine environment that can have very substantial effects on anadromous fish. However, the City does have the ability to: shape land management practices in the upper two-thirds of the basin; address the effects of the migration barrier formed by the Landsburg Diversion Dam; and exercise some level of control over stream flows in the mainstem throughout the historic range of Cedar River salmon and steelhead.

b. Natural Hydrologic Patterns and Basis for the Conservation Strategies

During the last 10,000 years or so, salmon and steelhead in the northwest radiated into an array of habitats and have adapted to the general environmental conditions that were present in specific watersheds throughout the region as the continental glaciers receded at the end of the last ice age (NRC 1996). One of the key factors to which these species have adapted during this period is the general hydrologic pattern in the watershed to which they home as adults, incubate as eggs and alevins and rear as juveniles. Therefore, anadromous fish will likely benefit when annual hydrologic patterns in regulated rivers generally resemble natural patterns (Beschta 1997).

As described in the Response to Public Comments, General Comment #38 (City et al., 1999b), several features of the minimum flow regime has been shaped to mimic the general pattern of the annual hydrologic regime in the Cedar River basin. That Response to General Comment #38 also details the considerable range of natural hydrologic variability over the 64 year period of record. In addition, the relocation of the instream flow measurement point to Landsburg will promote a more natural short-term hydrologic pattern throughout the river and especially in the 21.8 stream miles downstream of Landsburg. Constraints on the rates at which City facilities can allow stream flows to drop (down-ramping rates) will help keep short term flow fluctuations more similar to rates and magnitudes of natural short-term fluctuations. The provision of supplemental flows when hydrologic conditions are appropriate will result in seasonal flows that tend to fluctuate in a more natural manner than the present relatively static IRPP minimum flow regime.

The HCP flow regime and associated protective provisions attempt to reflect natural hydrologic patterns in several ways. First, the minimum flow regime has been designed to mimic the natural hydrologic patterns in the Cedar River Basin. Flows begin to increase between mid-September and mid-October when fall rains typically begin to arrive, soil moisture increases, and surface runoff begins to increase. Flows remain elevated during the winter and into the spring for the duration of the normal wet period of the year. In late spring, flows begin to decrease as runoff from rainfall and snowmelt in the relatively low-elevation Cedar River basin begins to decline.

Flows continue to recede throughout the summer, reach dry season base flow levels by early August, and remain at that level until the return of the wet season in the fall.

Second, the primary minimum instream flow measurement point will be relocated from its present location near the mouth of the river at Lake Washington, to the vicinity of the City's water supply diversion facilities approximately 20 miles upstream. The relocated measurement point will encourage more natural short term variations in flow throughout the river and especially in the 21.8 miles downstream of the Landsburg Dam.

And finally, the provision of additional supplemental flows when conditions allow will encourage a trend toward more natural fluctuations in the annual hydrologic patterns than under the current, relatively static regime. See the HCP and IFA for details of how and when those supplemental flows would be provided.

While the instream flow conservation strategy considers natural hydrologic patterns, simply attempting to mimic general natural hydrologic patterns is perhaps overly simplistic and insufficient to ensure the provision of high quality salmonid habitat in an highly altered environment. This rather broad, high level approach is important and informative, but misses much of the complexity inherent in the relationships between stream flow and habitat quality. This added complexity can be partitioned into three general categories.

First, while salmon and steelhead display a tendency to adapt to specific and unique conditions in particular watersheds, as species they also display considerable plasticity. For example, robust anadromous salmonid populations are found in systems with a rather broad range of hydrologic conditions, from systems that exhibit quite sudden and dramatic flow fluctuations in response to phenomena such as rain-on-snow events, to very stable, spring fed systems in which flow variations are quite limited. Secondly, the specific micro-habitat preferences of various species and life history stages of anadromous fish are complex, somewhat variable, and can be found in a relatively broad range of geomorphic conditions and stream channel types.

And third, the anadromous fish habitat in the Cedar River Basin has been rather dramatically altered by anthropogenic activities during the twentieth century. The relationships between fish habitat and stream flow in the present channel, which is highly constrained and much narrower than the original channel, are far different than the relationships that existed when the channel was in a natural condition. To further complicate matters, the changes in the drainage patterns of the Lake Washington basin that occurred with the construction of the Ballard Locks and re-

routing of the Cedar River into Lake Washington resulted in rather dramatic ecological changes in the system and a shift in fish species composition. In the Cedar River these alterations likely resulted in the extirpation of pink and chum salmon and have created challenging conditions for ocean-type chinook salmon but have provided conditions under which sockeye salmon were able to flourish.

c. Flow Objectives

The objectives established for this element of the HCP support the goal of avoiding, minimizing, and mitigating the incidental take of species listed as threatened, and treats unlisted species as if they were listed. The specific objectives listed below were developed to help guide the City's efforts to manage instream flows in a manner that protects anadromous fish and their habitat while preserving and protecting the municipal water supply.

- (1) Implement a beneficial instream flow regime, based on the best current scientific information, that will help provide high quality fish habitat throughout the potential range of anadromous fish in the Cedar River from Lake Washington to the natural migration barrier formed by lower Cedar Falls;
- (2) Reduce the risks of stranding juvenile salmonids and dewatering salmonid redds to levels that will promote the recovery and survival of anadromous salmonid populations in the Cedar River;
- (3) Provide an instream flow regime that significantly improves existing habitat conditions for all five species of anadromous salmonids in the Cedar River over existing conditions;
- (4) Maintain the supply capacity from the municipal water system, including the Cedar River, as measured by average annual firm yield, protect drinking water quality and public health, and preserve the operational flexibility necessary to water supply operations;
- (5) Help support measures that will contribute to improving downstream migration conditions for juvenile salmonids at the Ballard Locks; and
- (6) Preserve flexibility to meet water needs for people and fish that may be identified in the future.

d. Overview of Instream Flow Management Strategy

To meet these objectives, the City uses eight categories of conservation measures.

(1) The HCP attempts to shape flows in a manner that improves conditions for anadromous fish, using the best available information (Table 1). For example, guaranteed and supplemental flow assurances that better mimic the shape of the natural hydrograph and are typically greater than the flows required to provide maximum weighted usable area (WUA) for key species and life stages are tailored to meet the needs of anadromous salmonids.

(2) Limits on the City's future annual diversions, implementation of a monitoring program, and oversight by an interagency Commission providing flexibility and commitment to shape flows above guaranteed levels for greater ecological benefit.

(3) The HCP flow regime will provide supplemental flows above guaranteed commitments as allowed by specific hydrologic conditions in the watershed and as warranted by the biological requirements of fish. For example, supplemental flows are designed to be available for: spawning chinook in late September; spawning sockeye in September through early December; emigrating sockeye and chinook fry in February through mid-May, and incubating steelhead from mid-June through early August.

(4) The rate of stream flow reduction by operations of the hydro-electric facility, water storage, and the diversion structure will be limited to specific ramping rates to reduce the risk of stranding juvenile fish.

(5) Relocation of the flow compliance point 20 miles upstream for improved operating precision, improved protection of the upper portions of the lower river and to encourage more natural patterns of flow variation throughout the lower river.

(6) The provision of guaranteed flows in the bypass reach between Masonry Dam and the Cedar Falls powerhouse that will improve conditions for fish that are passed upstream of the Landsburg Dam.

(7) An increase over current conditions in the guaranteed amount of water that flows into Lake Washington during the period of maximum water use at the Ballard Locks between June 15 and September 30 for more flexibility to provide beneficial fish passage conditions through the locks facilities.

(8) The HCP recognizes that a significant volume of unallocated water is often available above the instream commitments and water supply needs of the City, and that future studies and developments may reveal beneficial instream or out-of-stream uses for some of this water. The adopted changes to the HCP by the City Council address this issue by

specifically reserving 100 MGD of the unallocated water for benefits to fish (City of Seattle 1999). Note that the City uses an annual average of 118 MGD (actual use has ranged from 85 to 144 over the last 50 years). This adopted change would allow the City to withdraw sometime in the future as much as 82 MGD, measured on an annual average, depending on the amount reserved. The HCP also provides for an interagency Instream Flow Committee which will serve as a forum for sharing of information and discussion concerning potential use of this unallocated water.

e. Species and Life History Stages Prioritized

A basic understanding of the life history of the salmon and steelhead species is important for recognizing and understanding the likely impacts associated with different flow regimes. From the strict standpoint of WUA, the primary species and life history stages of interest are spawning and rearing chinook, coho, and steelhead and spawning sockeye (sockeye fry migrate immediately to Lake Washington after emergence and therefore do not rear in the river). Differences in the timing of life history stages mean that flows most advantageous for a particular life history stage of one species may not be effective for another. Figure 1 displays the timing of the key species and life stages used by the CRIFC in developing various flow regimes. Because each species and life stage has different habitat preferences it is not possible to achieve maximum WUA for all species and life stages at a single river discharge when timing of species and lifestage in the river overlap. For example, WUA for spawning sockeye is achieved at 105 cfs whereas peak WUA for spawning chinook is achieved at 275 cfs (measured at Landsburg). When the WUA/discharge function of two different species or life stages do not overlap but timing does, species prioritization decisions must be made. One answer is to optimize habitat for all species and life stages. Basically, this is an averaging technique and is not generally accepted by the WDFW and WDOE. The other solution is to prioritize species and life stages and attempt to maximize WUA accordingly.

The CRIFC took the prioritization approach to establish instream flows for Proposed HCP. The rationale for species and life history stage prioritization used for development of the proposed flow regime are elaborated in Section 4.4.2 in the Draft HCP. Through the remainder of this chapter, species and life history stages that were considered the primary focus for establishment of instream flows during any particular period are referred to as *key species and life history stages*. The proposed HCP instream flow regime attempts to address key species and life history requirements while minimizing conflicts between species. Species specific life history stages that required the greatest discharge at any time of the year were first used as a foundation for development of instream flow regimes. The CRIFC realized some features of habitat quality important for key species and life history stages cannot be effectively protected by simply maximizing WUA. Additional provisions were added to address other key factors that are important in maximizing habitat quality and fish production. Table 1 displays the primary species and life history stage considerations the CRIFC focused on for establishing flow regimes.

These same considerations were used in analyzing the effects of the HCP flow regimes.

Coastal cutthroat trout were not included in the studies because their smaller size and preference for small size streams and tributaries indicated they are much less influenced by Cedar River instream flows than other salmonids. Instream flows that meet the needs for the four studied species are expected to also provide adequately for cutthroat.

The proposed HCP flow regime is based on more than 10 years of extensive, collaborative study and analysis of the need of all life stages for four of the five anadromous salmonid species (i.e., chinook, coho, steelhead, and sockeye). It is intended to provide beneficial habitat conditions for all life stages (spawning, incubation, rearing, holding, and migration) of anadromous salmonids (Table 1). PHABSIM analyses and a number of additional biological investigations were conducted as part of a 5-year IFIM study overseen by the interagency CRIFC (CES 1991). A number of subsequent hydrologic analyses and biological investigations, conducted both jointly and independently by members of the CRIFC, were also used in the development of the proposed instream flow management regime. The HCP guaranteed flow regime prescribes not only minimum instream flow requirements, but also includes adaptive provisions for the allocation of supplemental flows, when hydrologically available, through operation of a multi-agency Instream flow Oversight Commission (IFA, detailed in Appendix 27 to the HCP).

4. Instream Flow Incremental Methodology

The effects of stream flow on fish and fish habitat in the Cedar River have been the subject of substantial study for the past 30 years. Early work conducted by the United States Geological Survey and Washington Department of Fisheries (Collings et al. 1970, Collings 1974, cited in the HCP) was used by the Washington Department of Ecology to establish minimum instream flow recommendations for the Cedar River in 1971(WWRA, 1971, cited in CES 1991). Using this early work, coupled with additional studies conducted by the University of Washington (Stober and Greybill 1974, Stober et al. 1976, Stober et al. 1978, Stober and Hamalainen 1979, Stober and Hamalainen 1980, Miller 1976, all cited in the final HCP), the WDOE established a new set of minimum instream flows recommendations for the Cedar River in 1979 (WDOE 1979).

In 1986 the Cedar River Instream Flow Committee (CRIFC) was formed with the goal of using the best available science to conduct additional, collaborative investigations of the instream flow needs of aquatic resources in the Cedar River. The CRIFC was composed of representatives from the WDF, the WDFW, the WDOE, the MIT, the NMFS, the FWS, the ACOE, and the City of Seattle. The CRIFC called for and directed all aspects of a new set of studies conducted around a core approach provided by the Instream Flow Incremental Methodology (IFIM). IFIM is a decision- support system designed to help natural resource managers and their constituencies determine the benefits or consequences of different water management

alternatives@ (Bovee et al. 1998, cited in the final HCP). The methodology is a broad-based approach that includes a library of linked analytical procedures that is grounded in ecological principles and is continuing to evolve. It provides a framework within which a number of different analytical tools can be developed to investigate the effects of stream flow on aquatic resources. IFIM can be used to help integrate the effects of natural and managed hydrology, instream and out-of-stream uses, and conflicting institutional interests with the biological requirements of aquatic species.

The CRIFC selected a contractor to perform selected studies and oversaw all aspects of the study planning, design, implementation, interpretation and reporting of results. These studies were completed between 1986 and 1991 and published as the Cedar River Instream Flow and Habitat Utilization Studies in late 1991 (CES 1991) (see Section 3.3.2 of the draft HCP). The studies included extensive Physical Habitat Simulation Analyses (PHABSIM) (Bovee 1982, 1986, cited in the HCP) and a number of additional biological investigations. The CRIFC used this information, coupled with additional hydrologic analyses, steelhead incubation studies and preliminary juvenile sockeye emigration information as the primary information base for developing the HCP instream flow management regime. The CRIFC identified all life stages of chinook, coho, sockeye and steelhead as the primary focus of the studies. The species were considered keystone species in subsequent discussions and negotiations of an instream flow management regime from late 1993 through 1997. Life history periodicity information for the four species is provided in Figure 1. A summary of key considerations for the various species and life history stages throughout the year is presented in Table 1.

During the collaborative instream flow studies and development of the HCP instream flow management regime, the interagency Cedar River Instream Flow Committee viewed the extensive PHABSIM analyses conducted on the Cedar River as a foundation for an instream flow management regime rather than as a prescriptive tool for determining preferred flows at any give time during the year. While the City believes that PHABSIM analyses are an important tool in developing effective instream flow management practices, anadromous salmonid biology is complex and habitat requirements for these species are not completely described by standard PHABSIM analyses. Additional information is helpful in prioritizing species and life stages during particular times of the year; addressing aspects of their biology not typically analyzed in standard PHABSIM investigations; and understanding the complex relationships between hydrologic variation and natural ecological processes in the aquatic environment. During the course of collaborative studies and subsequent development of the HCP instream flow regime, a broad array of information was used in an effort to establish management provisions that would provide comprehensive protection for all life stages of anadromous fish and the habitat upon which they depend. These management provisions address key biological considerations determined to be of particular importance to Cedar River anadromous fish by the CRIFC and include:

- Limits on the rate at which stream flows can be reduced as a result of City's water

management activities to reduce the risk of fish stranding and better reflect natural rates of stream flow recession;

- Increased guaranteed flows during the fall to recruit additional sockeye spawning habitat along the margins of the stream and potentially reduce sockeye redd scour vulnerability during subsequent winter peak flow events;
- Increased guaranteed flows during the chinook and sockeye incubation season in the fall, winter and spring to reduce the risk of redd dewatering;
- Increased guaranteed flows during the late winter and early spring to provide improved emigration conditions for sockeye fry;
-
- Steelhead redd monitoring program and flexible blocks of supplemental water during the summer for increased flows to reduce the risk of steelhead redd dewatering;
-
- Higher guaranteed flows into Lake Washington for more flexibility to provide beneficial fish passage conditions at the Ballard Locks; and
- A number of commitments that will result in stream flows that better reflect natural hydrologic patterns including: i) relocation of the flow compliance point 20 miles upstream to Landsburg; ii) supplemental guaranteed flows linked to real time hydrologic conditions; and iii) collaborative management of flows above guaranteed levels to support important natural ecological processes and provide benefits to fish.

a. Physical Habitat Simulation Analyses (PHABSIM)

Within the IFIM approach, PHABSIM analyses provide an important tool for investigating the effects of stream flow on the physical components of fluvial fish habitat. PHABSIM analyses are based on the premise that habitat conditions preferred by different species and life stages of stream-dwelling fish vary within the channel as a function of flow. Or, stated more precisely, stream-dwelling fishes prefer specified ranges of depth, velocity, substrate, and cover type and the availability of these preferred habitat conditions varies with stream flow. PHABSIM analyses use a set of computer models developed by the USFWS to integrate individual species and life stage habitat preferences with measured, river specific stream depth, velocity, substrate and cover type to generate an index of habitat availability for particular species and life stages over a range of stream flow levels. This index of habitat availability is termed Weighted Usable Area (WUA) and is measured in square feet of habitat for a defined species and life stage per linear length of stream.

For example, chinook salmon have a preference for a certain range of water depths, velocities and substrate size for spawning. For the Cedar River, the CRIFC determined that preferred spawning depth for chinook ranged from 0.75 feet to 3.4 feet, preferred spawning velocity ranged from 1.0 feet per second to 3.5 feet per second and preferred substrate particle size ranged from 0.5 inches to 6.0 inches. The river discharge that provides the greatest area of these combined habitat preferences is commonly referred to as the flow that provides maximum WUA for chinook spawning and would be represented by the peak of the chinook spawning WUA curve (Figure 2). WUA is generally curvilinear. WUA typically increases as river discharge increases up to a certain level and then WUA decreases as river discharge reaches a level that produces depths and velocities that are beyond the fish's habitat preference. The fact that WUA decreases to the right of the peak (as discharge increases) is an important aspect of the WUA function and is integral to discussions throughout this section.

By integrating the output from PHABSIM analyses for a particular species and life stage (such as spawning chinook salmon) with expected stream flows over a specified period of time (such as the fall chinook spawning season), habitat duration analyses may be generated to compare aggregate habitat availability for different potential flow regimes. In Appendix 36, the City presents analyses that describe and compare historic Cedar River stream flows, flows expected to occur under the HCP flow regime, and flows expected to occur under future conditions without the HCP flow regime. This information, coupled with modeled unregulated flows, was then used to generate the series of habitat duration analyses in provided in Appendix 37 for various life stages of chinook, coho, sockeye and steelhead. Habitat duration analyses allow investigators to compare total WUA and WUA distribution over time for given species and life history stages for different stream flow regimes over specified time periods. For example, these analyses compare total aggregate chinook spawning WUA during the fall chinook spawning season as whole for three different stream flow regimes: flows expected under the HCP regime; flows that occurred historically under the IRPP regime; and predicted flows that would occur under natural conditions without regulation by the City's water management facilities. As an example, the results presented in Appendix 37 of the proposed HCP demonstrate that, under nearly all hydrologic conditions that might occur, the HCP instream flow regime will provide more WUA for chinook spawning during the fall spawning season than either historical flows or predicted natural unregulated flows.

The collaborative PHABSIM analyses were used to establish the relationship between stream flow and habitat availability for the four studied anadromous species. Results are expressed in terms of total WUA for the various species and life stages. Habitat availability, expressed as WUA, is one key factor that has been used in the development of the HCP flow regime. From the strict standpoint of WUA, the primary species and life stages of interest are spawning and rearing chinook, coho and steelhead and spawning sockeye (almost all sockeye fry migrate immediately to Lake Washington after emergence and therefore do not rear in the river). For most of the year, HCP normal guaranteed flow commitments are designed to be equal to or

greater than the flows required to provide maximum WUA for all life history stages of the four studied anadromous fish species.

Because each species and life stage has different habitat preferences, it is not possible to achieve maximum WUA for all species and life stages at a single river discharge when timing of species and life stage in the river overlap. For example, Figure 2 illustrates that peak WUA in Study Reach Number 1 for spawning sockeye is achieved at 125 cfs, whereas peak WUA for spawning chinook is achieved at 350 cfs. When the WUA/discharge function of two different species or life stages do not overlap but timing does, species prioritization decisions must be made. One answer is to optimize habitat for all species and life stages. Basically, this is an Aaveraging® technique and is not generally accepted by the WDFW. The other solution is to prioritize species and life stages and attempt to maximize WUA accordingly. The latter approach was taken by the CRIFC.

b. Criticisms of IFIM and PHABSIM

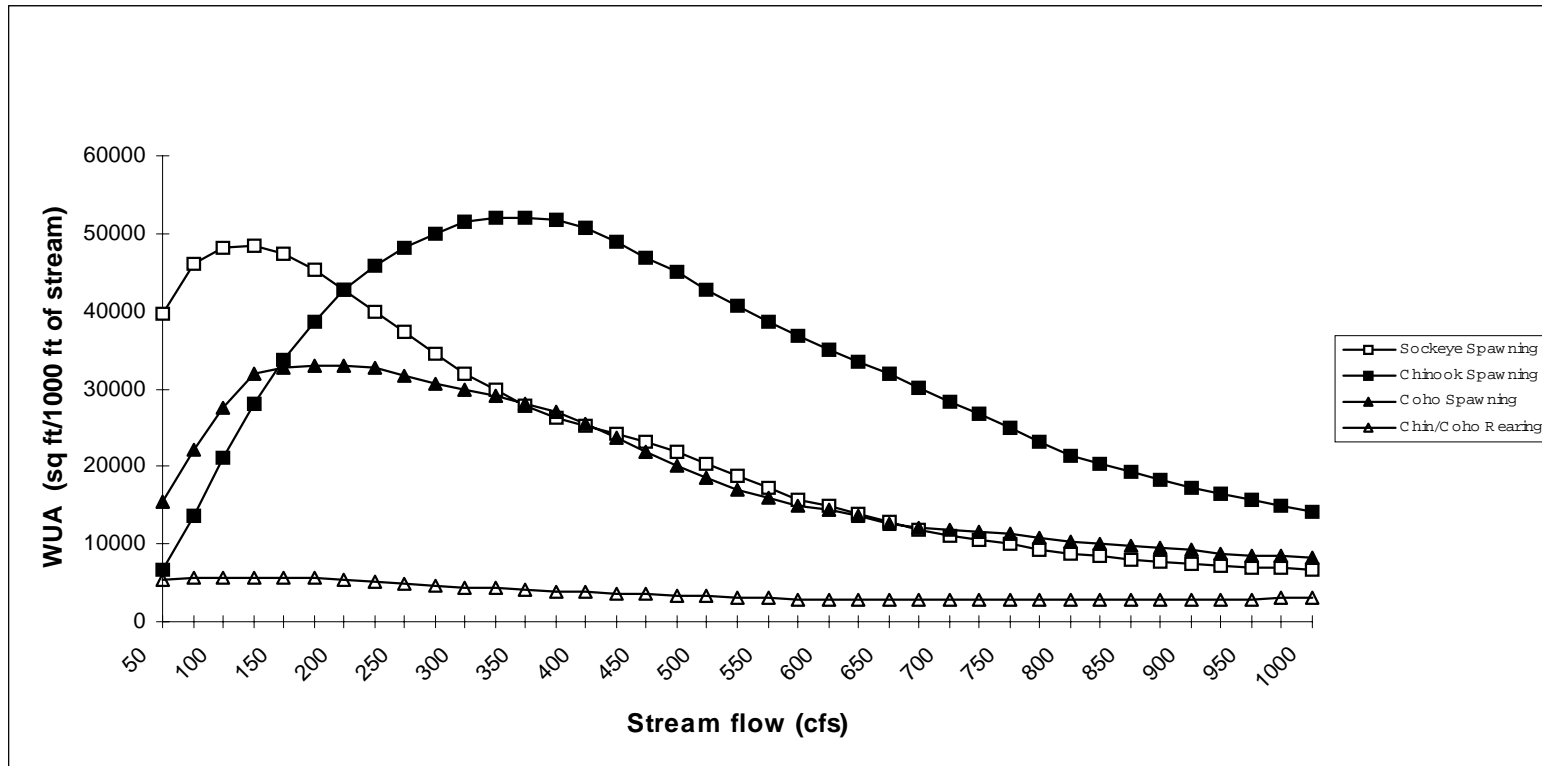
There have been general criticisms of IFIM and PHABSIM (Castleberry et al. 1996, Kondolf et al. 1999). As well, specific comments on the HCP proposed flow regime were received and addressed in the Response to Public Comments (City et al., 1999b). Critical comments, both general and specific, were carefully reviewed and weighed against the detailed record of development of the proposed HCP instream flow regime (CES 1991; Appendix III to the Agreement in Principle, 1997; Appendices #8, 35, 36, 37 to the HCP; Response to Public Comments (City et al., 1999b); and other recorded documents from the CRIFC discussions, c. 1990 -1997).

As described below, PHABSIM was used by the CRIFC in initial considerations to design a weekly regime of guaranteed instream flows throughout the year. As discussed below under Additional Habitat Considerations, other biological and operational considerations were then added and discussed by the CRIFC to arrive at the proposed HCP flow regime. Also considered were spawner run-timing curves, accretion flow analysis, and preliminary sockeye-fry emigration studies. WUA derived by PHABSIM was an important, but by no means the sole determinant used to assess the adequacy of the proposed instream flow regime for each of the four key species of anadromous fish.

The CRIFC did not define instream flow standards for each fish species solely on the basis of PHABSIM analyses. Rather, they employed a broad and robust approach to IFIM in which PHABSIM was used as one of a number of analytical tools to help analyze the effects of stream flow on fish and fish habitat. In addition, the committee used a number of hydrologic tools and analyses to assess the impact of various guaranteed flow regimes on water supply. If water supply was not a consideration, some of the prescribed supplemental stream flows could be provided with greater frequency and thus potentially provide more benefit to aquatic resources.

Water supply was also a consideration in developing the City's commitments to allocate part of its water claim to instream resources and to preserve flexibility to protect fisheries resources when managing flows in excess of guaranteed levels. Flows above the guaranteed levels can provide both beneficial impacts (e.g., habitat forming processes) and detrimental impacts (e.g., redd scour) on aquatic resources. If water supply considerations were eliminated, operators could potentially have more flexibility to manage these elevated flows in ways that maximize beneficial effects while minimizing detrimental effects. However, if water supply considerations were eliminated, then the City would lose the assurance for future water supply operations that was a primary factor motivating the City to prepare an HCP.

Figure 2. Example of the relationship between stream flow and habitat, or Weighted Usable Area (WUA), for salmon spawning and rearing in Lower Cedar River Study Reach number 1.



c. Application of PHABSIM Analyses

The HCP guaranteed and supplemental flow regime is summarized in Table 4.4-1 of the draft HCP. The relationships between guaranteed flows, the existing non-binding IRPP minimum flows and the flows that provide maximum WUA for key species and life stages as determined by collaborative PHABSIM analyses are summarized in HCP Figures 4.4-2 through 4.4-5. Expected actual flows will often exceed guaranteed flows during the fall, winter and spring because: (i) inflows to the basin often exceed amounts required to meet the guaranteed flows and municipal water supply demands; (ii) surface runoff in the lower 57% of the basin enters the Cedar River naturally and is not influenced by the water storage reservoir; and (iii) flood storage capacity in the reservoir is relatively limited. Although the total usable capacity of the two linked reservoirs is 77,500 acre-feet, little if any of that capacity would be available for flood storage during the seasons when storms cause floods, e.g., November through April. Expected actual flows under the HCP instream flow management regime, under the existing IRPP regime, and under natural unregulated conditions are summarized in HCP Appendix 36. Appendix 37 provides habitat duration analyses for expected actual flows under the HCP, IRPP and natural flow regimes using PHABSIM output for key species and life stages.

The first consideration in designing the HCP flow regime has been to attempt to provide flows that meet or exceed the flows required to provide maximum WUA as defined by the PHABSIM analyses for key species and life history stages throughout the year. PHABSIM is a powerful tool that is helpful in describing the relationship between stream flow and fish habitat and is a generally accepted methodology used to establish instream flow requirements for fish. However, the methodology entails some uncertainty and does not address all aspects of the biological requirements of fish. Recognizing that PHABSIM analyses would not provide all the necessary information for establishing the appropriate instream flow regime, the CRIFC requested many additional studies be conducted to complement the PHABSIM analyses (See Section 3.3.2 of the draft HCP). The flows required to provide maximum WUA have been used here as a foundation upon which additional flow is added to better address uncertainty and address additional key factors that can limit habitat quality and fish production.

As described in the previous section, the HCP guaranteed flows are designed to be substantially greater than the flows required to provide maximum WUA for key species and life history stages for the majority of the year. As flows increase above the levels required to provide maximum weighted usable area, water depths and velocities increase and the total amount of suitable habitat in the river generally decreases. Within this general pattern, spawning and rearing habitat availability vary independently and in different ways as flows change. For example, WUA for steelhead spawning increases as flows increase to a level of approximately 150 cfs as measured at Landsburg. When flows increase above this level, the amount of spawning habitat decreases rather markedly as depths and velocities in much of the channel increase beyond suitable ranges. In contrast, juvenile steelhead rearing habitat continues to increase as flow increase to a level of

approximately 75 cfs, then decreases only slightly as flows increase further because new low velocity habitat along the edges of the channel is recruited nearly as rapidly as low velocity habitat is lost in the rest of the channel.

For the three studied anadromous species that rear in the river (i.e., chinook, coho and steelhead), PHABSIM analyses demonstrate that WUA for juvenile rearing is less sensitive to changes in flows than is WUA for spawning. That is, for a given incremental flow change, the change in WUA for juvenile rearing is typically much smaller than the change in WUA for spawning. The analyses also demonstrate that the flows required to provide maximum WUA for spawning are much higher than the flows required to provide maximum WUA for juvenile rearing. For these reasons, and because WUA for juvenile rearing during the fall, winter and spring base flow conditions is not believed to be a major concern, spawning habitat and other considerations have generally been given higher priority in the Cedar River than rearing habitat availability.

There is one period during the year when there are no other overriding concerns and juvenile rearing is the primary focus of instream flow management. After the completion of steelhead incubation in early August and prior to the beginning of substantial chinook and sockeye spawning in mid-September, steelhead juvenile rearing is the key life history stage of concern. Juvenile coho salmon are also present at this time. However, the flows required to maximize WUA for juvenile steelhead are slightly greater than flows required to provide maximum WUA for either juvenile coho or juvenile chinook. Therefore, steelhead was selected as the key species of concern. During this time of year, instream flow considerations are typically important in determining the amount and quality of habitat available when juvenile fish are well dispersed and actively feeding and growing. Insufficient habitat availability at this time of year can potentially create a bottleneck for salmonids that rear in the river as juveniles.

In the fall, spawning conditions for salmon become a key biological consideration. By mid-September, substantial numbers of adult chinook salmon begin entering the river and maximizing chinook spawning habitat becomes a primary concern.

b. Some Limits of WUA

The following description of some of the limitations of relying solely on WUA when prescribing desired instream flows is excerpted from Ames and Beecher (1995).

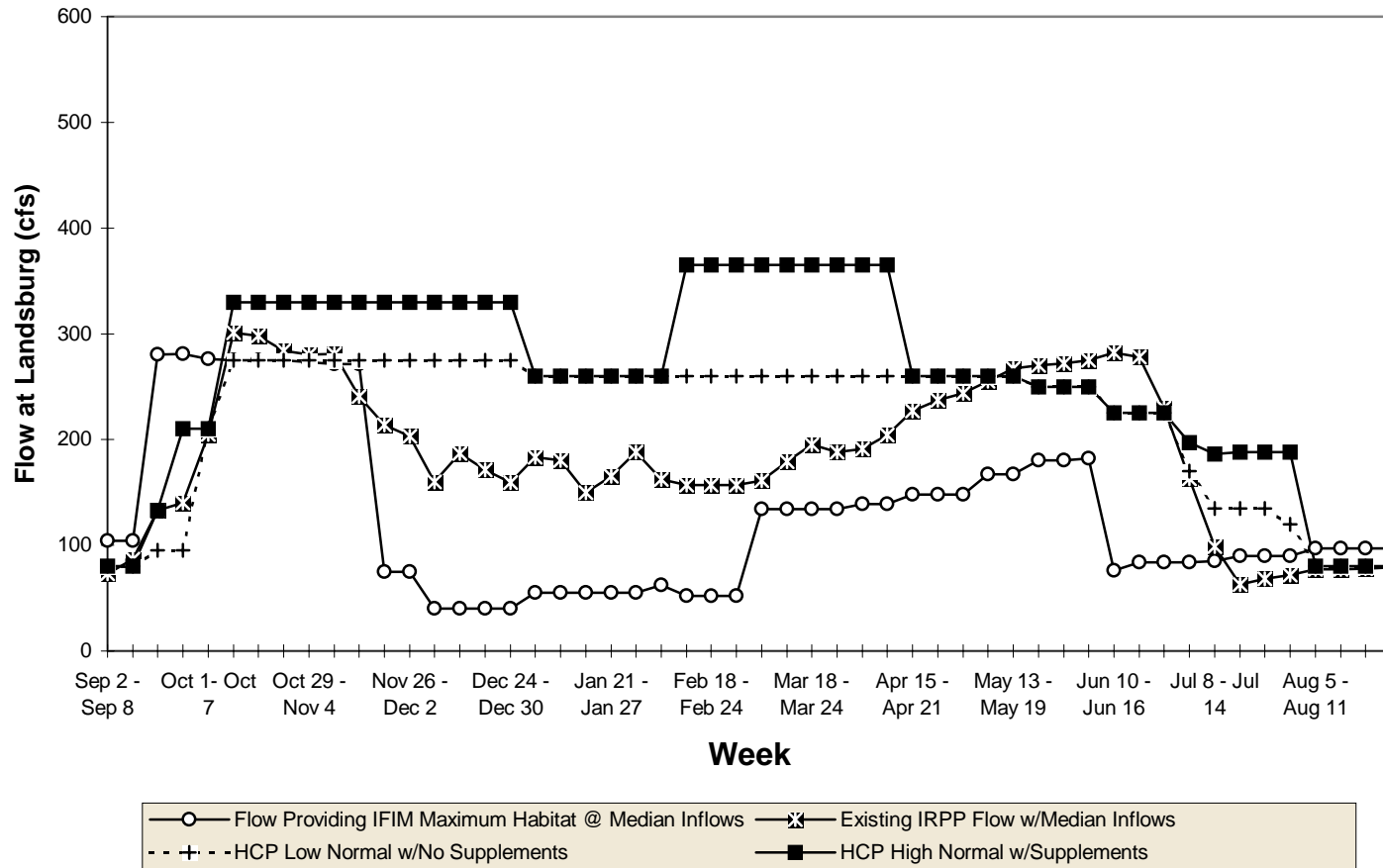
Weighted Usable Area is a measure of suitable habitat. It is area (square feet) multiplied by the suitabilities (from 0.0 to 0.1) for depth, velocity, and substrate. If depth, velocity and substrate are all ideal, then WUA will be equal to the area of that portion of the stream bottom, otherwise WUA will be less than the area of stream bottom. For any given part of the stream bottom that has suitable spawning gravel, the suitability of the gravel will be constant but suitability of depth and velocity will vary with changes in

flow. Spawning WUA is maximized by the combination of suitable depths and velocities over suitable substrate.

Spawning WUA is only a partial indicator of value of habitat for spawning. Fish select spawning habitat based on cues which include depth, velocity, substrate, and cover, as well as other parameters. Some of these factors (e.g., upwelling, pheromones, proximity to cover, proximity to bank) may not be incorporated in WUA.

Spawning is successful if it results in fry emerging from the gravel at a time and place that is conducive to further survival of the fry. If fish have a higher survival in one habitat than in another despite similar habitat value as indicated by WUA, then WUA is an incomplete measure of habitat value. Where additional knowledge of the biology of the fish allows discrimination between higher and lower survival values of areas of similar WUA, that knowledge should be incorporated into decisions about flow management.

Comparison at Landsburg of existing, non-binding IRPP flows, HCP flows, and flows required to create maximum Weighted Usable Area (WUA) as defined by the IFIM study for key species and life history stages.



5. Additional Habitat Quality Considerations

a. Fish Passage

Shallow depths across a riffle or gravel bar can create a low flow blockage that limits a fish's ability to swim upstream. The shallowest and widest riffle in the Cedar River downstream of Landsburg was identified during the collaborative instream flow studies. Using the PHABSIM cross section measurement methods and hydraulic model, the studies determined the flow required to allow adult chinook to pass over the low-flow passage barrier. Although the absolute minimum flow that would allow passage was not determined, the study demonstrated that passage of adult chinook would not be impeded at flows of 94 cfs or more as measured at the low flow blockage located 0.5 miles upstream of the confluence with Rock Creek.

b. Salmon Spawning Habitat in the Fall

In addition to providing adequate amounts of spawning habitat for chinook and sockeye, the flows in the fall have been designed to provide additional benefits for sockeye in two ways. First, the flows employ the potential benefits of a cumulative approach to providing sockeye spawning habitat in contrast to a static approach. The regime attempts to increase available sockeye habitat over and above the amount provided by the static flow providing maximum WUA by incrementally increasing flows to recruit new habitat after habitat recruited at lower flows has been previously seeded. As flows increase, depths and velocities over habitat seeded earlier exceed suitable levels for spawning and fish are forced to spawn in other areas including new habitat recruited by the increasing flows. As flows increase, the rate of habitat loss is greater than the rate at which new habitat is acquired. If, however, this lost habitat was previously seeded when flows were lower, then it still contributes to the total productive cumulative sockeye spawning habitat. Flows at the beginning of the sockeye spawning season have been established at, or slightly above, the value providing maximum WUA. Flows are then gradually stepped up over the next 3 weeks of the spawning season to recruit additional new habitat. After 3 weeks of flow increases, some calculated amount of sockeye spawning habitat has been lost. However, if this lost habitat was previously seeded, it remains productive and is now less vulnerable to damage from the activities of subsequent spawning fish because sufficient flows are provided for egg incubation.

Secondly, the increasing flow levels recruit new spawning habitat along the margins of the streams that is believed to be less vulnerable to scour than areas of the mid-channel (Ames and Beecher 1995). Thus, the loss in WUA for sockeye spawning during flow increases in the fall can be offset by an increase in cumulative spawning habitat and recruitment of sockeye spawning habitat that is less vulnerable to scour. By spreading the eggs throughout the channel, incubation

habitat is diversified and, over the long term, is expected to be more resilient and less vulnerable to variations in environmental conditions.

c. Incubation Protection

Incubating alevins can experience substantial mortality during short periods of dewatering. By ensuring minimum flows at appropriate levels, risks to incubating salmon and steelhead can be greatly reduced. In the Cedar River, incubating salmonids are present in substantial numbers from approximately mid-September until the end of July. Minimum flow commitments during this time have been designed to help reduce the risk of short-term redd dewatering.

Because steelhead incubate during the period of a naturally declining hydrograph in the Cedar River, they can be especially vulnerable to dewatering under certain circumstances. In addition to increased flows during the latter portion of the incubation season, the HCP also provides real-time monitoring and adaptive management to help ensure that additional water is distributed appropriately to help protect incubating steelhead.

d. Emigration Conditions for Sockeye

Sockeye fry emerge from the gravel during the late winter and spring and migrate directly downstream to Lake Washington where they rear for a year prior to migrating to sea. Preliminary studies conducted independently by WDFW suggest that most fry arrive at Lake Washington within 48 hours of emergence and that their survival during their downstream migration is positively correlated with stream flow (Seiler and Kishimoto 1996, cited in the HCP).

Spring is a challenging time for water management on the Cedar River. Management strategies are attempting to meet multiple objectives, including: refilling the Chester Morse Lake Reservoir; providing suitable flows for sockeye outmigration; preventing sustained high flows to avoid inducing steelhead to spawn in areas that are at high risk of being dewatered; flood management; and minimizing the impact of reservoir level fluctuations on nesting loons, incubating bull trout and shoreline wetlands. In an effort to benefit emigrating sockeye, minimum flow commitments have been set higher than the existing flow regime during this period. The HCP regime also provides even higher flows 70 percent of the time in a manner that attempts to minimize subsequent risks to incubating steelhead.

e. Protection from Stranding

Many of the benefits of the previously described conservation measures can be negated by excessive and frequent flow fluctuations that strand juvenile fish. Therefore, to help secure all the benefits provided by the various components of the instream flow conservation strategy, the

City will commit to a set of downramping prescriptions that are very similar to downramping guidelines established by the State of Washington (Hunter 1992, cited in the HCP).

f. Delivery of Water to Lake Washington

On an annual basis, the Cedar River provides approximately one-half the total inflow to Lake Washington. The total volume of inflow to Lake Washington during the dry season is especially important for protecting water quality, for managing water levels in Lake Washington and providing suitable conditions for fish passage and vessel traffic at the Ballard Locks. The HCP instream flow regime will ensure that, under conditions of minimum flow, more water will flow down the Cedar River into Lake Washington than under the existing flow regime, for the key period of concern from June 17 through September 30. ACOE, which is responsible for managing the lake levels, lockage flows, and fish-passage at the locks, will have a role on the Instream Flow Oversight Commission (IFOC) that will recommend flow adjustments to the City.

g. Normal and Critical Flow Regimes

Normal and critical flow regimes refer to the provisions in the IFA for a normal flow schedule and a critical flow schedule. Normal minimum flows are defined as the minimum instream flow rates that the City will provide except under very adverse and infrequent hydrologic conditions, during which time critical instream flow rates apply. Critical flow rates would apply only under adverse drought conditions and would be expected at a frequency of approximately once in 10 years on the average, and are based on the past 60 years of low record.

The proposed HCP regime provides opportunities for increased stream flow commitments during periods of key importance to anadromous fish. The precise timing and distribution of these flows will vary from year to year depending on hydrologic conditions, biological need, and direction from the Parties to the IFA.

h. Accretion Flows

In order to understand the stream flow commitments in the proposed HCP, as measured at river mile 20.4 near Landsburg, compared with the existing flow regime as measured at river mile 1.6 in Renton, it is necessary to account for flow accretion into the river between Landsburg and Renton. Flow accretion is the gain in river discharge between two points due to surface or subsurface inflows from tributaries, seeps, or upwellings. Also, in order to correctly quantify the amount of habitat relative to the optional Renton or Landsburg control points, it was necessary to determine the cumulative discharge at IFIM study locations and Renton relative to any given discharge as measured below the Landsburg Diversion Dam.

An extensive investigation of inflows between the two points was conducted as part of the Cedar River Instream Flow and Salmonid Habitat Utilization Study (CES 1991). The investigations resulted in the production of a model providing mean weekly inflows for the full range of hydrologic conditions experienced between 1929 and 1988 (HCP Appendix 8).

i. Lower Cedar Falls to the Masonry Dam

The HCP includes a commitment to provide rearing flows in the 0.5 mile bypass reach immediately upstream of the powerhouse and also provides protection for the reach between the powerhouse and Landsburg. The minimum flows for the bypass reach protect habitat within the bypass reach and provide a new floor below which flows cannot drop between Landsburg and the powerhouse.

A new stream gage will be established just upstream of the hydropower tailrace. This gage will be installed to monitor compliance with the City's commitment to provide rearing flows for anadromous fish in the bypass reach between Lower Cedar Falls and the hydroelectric project once fish passage facilities are completed at the Landsburg Diversion Dam.

j. Adaptive Features of the Instream Flow Regime

Although a substantial amount of information was assembled over the last 10 years to guide the development of the HCP instream flow regime, the City anticipates that additional information will become available as the science of fluvial systems and strategies for managing stream flows in altered channels continue to evolve. In addition to well-defined, binding instream flow management commitments, the City acknowledges the need to provide sufficient flexibility to adapt and improve instream flow management strategies, as new information becomes available.

The conservation measures of the HCP, while expected to continue providing for the long-term survival of ESA-protected species, may someday be found to result in levels of adverse impacts that warrant a further analysis by NMFS to assess potential jeopardy to a species. Any conflict between jeopardy and the assurances offered under No-Surprises must be resolved in favor of the species. See a more complete description of this matter in the Findings (iii).

The HCP provides over \$ 3.4 million for further studies to: (i) monitor natural and regulated stream flows throughout the basin; (ii) better quantify the effects of natural local inflows on stream flow in the Cedar river downstream of municipal watershed; (iii) improve the ability of stream flow switching criteria to accurately reflect natural hydrologic conditions; (iv) improve understanding of key aspects of the biology of chinook salmon and other salmonids in the Cedar River; and (v) better understand the general effects of stream flow management of fish habitat in

altered fluvial systems. Finally, the HCP establishes an IFOC (Section 4.4.2 and Appendix 27) that will make use of the information gathered during future studies to guide the management of stream flows over and above the guaranteed levels to provide additional benefits for instream resources.

To make good instream flow management decisions, managers must be supplied with accurate and reliable information. Current information on the early life history of chinook salmon is limited. To address this information gap and support instream flow management decisions, the final HCP provides an additional \$1 million dollars specifically earmarked for studies that address the early life history of chinook salmon and other key life stages of anadromous salmonids in the Cedar River (Section 4.5.2). Study results will be available to be used by the Cedar River IFOC to help make well informed and balanced (i.e., between species) instream flow management decisions during the spring and other key periods of the year.

Table 1. Key instream flow considerations used by the CRIFC during development of proposed HCP flow regime for anadromous fish in the lower Cedar River.

Time Period	Primary Species and Life History Life Stage	Additional Important Considerations
Mid-Sept. to Mid-Nov.	Quantity of chinook spawning habitat	Cumulative habitat and edge habitat for spawning sockeye Protect incubating salmon Quantity of juvenile rearing habitat
Mid-Nov. to End Dec.	Edge habitat for spawning sockeye	Protect incubating salmon Quantity of coho spawning habitat
End Dec. to Early Feb.	Salmon incubation protection	Quantity of coho spawning habitat
Early Feb to mid-April	Emigrating sockeye fry	Protect incubating salmonids Quantity of steelhead spawning habitat Avoid excessively high sustained flows that force steelhead to spawn in areas where redds will be vulnerable to dewatering
mid-April to early June	Avoid excessively high sustained flows that force steelhead to spawn in areas where redds will be vulnerable to dewatering	Emigrating sockeye fry Quantity of steelhead spawning habitat Quantity of juvenile rearing habitat Protect incubating salmonids
Early June to early Aug.	Protect incubating steelhead	Quantity of juvenile rearing habitat
Early Aug to Mid-Sept.	Quantity of juvenile rearing habitat	

It is important to note that, as used in this analysis, the term *instream flows* includes both the *guaranteed minimum flows* and the *supplemental (i.e., non-firm) flows* detailed in the IFA that, taken together, represent the minimums that are believed to be necessary for each species to survive over both short and long-term. The *minimum flows*, without the *supplemental flows*, are not considered sufficient for long-term survival of some species, according to resource agency flow experts engaged in the multi-agency CRFIC.

k. Stream Flow Commitments

The City will operate its facilities on the Cedar River to ensure that stream flows remain above certain specified levels to protect fish habitat, as summarized in the HCP (Figure 4.13 and Appendix 27). The measurement point for these stream flow commitments will be moved upstream from RM 1.6 to the existing USGS stream gage #12117600 located at RM 20.4, which is 1.4 miles downstream from the Landsburg Diversion Dam.

The City will commit to a binding set of weekly minimum instream flow commitments that will replace the current non-binding flow targets. The general shape of the HCP minimum flow commitments will follow the general shape of the natural annual hydrograph. Flows begin to trend upward in the early fall as rainfall and runoff typically increase. Flows reach relatively high levels by early to mid-October and continue at elevated levels until late spring when they begin to trend lower, reaching summer base flow levels in late July and early August. Flows remain at base levels until the start of the early fall increase in releases for spawning salmon.

As with the existing non-binding flow regime, the HCP minimum instream flow commitments consist of normal flows and critical flows. Critical flows would apply only under adverse conditions in which specified hydrologic criteria have been met and public notification and water conservation measures specified in the City's water shortage contingency plan have been implemented (Appendix 10 of the HCP). Switches to critical flows would be expected at a frequency of approximately once in 10 years on the average and would be implemented according to specific criteria and procedures described in the Instream Flow Agreement (Appendix 27).

Also, in the wetter periods of most years, in addition to the water currently withdrawn by the City and the instream flows, there are various amounts of unallocated water that are not withdrawn by the City. Most of this unallocated water is now allowed to be added to the instream flows and presumably provides benefits to aquatic resources and some life stages of fish in ways that cannot be quantified at this time. The water claim by the City could allow withdrawal of some this unallocated water and that potential increase in diversion has an unknown potential to result in effects to fish. In order to ensure that some of the water which it may be entitled to withdraw under its water right should instead be left in the river for the benefit of fish over the term of the

HCP, the City intends to develop and implement a legal mechanism such as a trust or other arrangement by which it can reserve, for the length of the HCP, one-third or 100 mgd of its water right claim (on an annual average basis) for the benefit of fish, subject to the following conditions: i) that the water so reserved is available to the City for emergency situations (natural disasters, pipeline failures, water quality events, extreme drought, and system failures); and ii) that the reserved water is protected from appropriation by third parties. It is also the City's intent to reserve an additional one-sixth or 50 mgd of its water right claim (on an annual average basis) through the same mechanism and subject to the same conditions described above, and subject to the additional condition that the City resolves some outstanding issues with the Muckleshoot Indian Tribe.

1. Relationship of Instream Flows to Anadromous Fish Habitats

All five species of fish now spawn and rear in the lower Cedar River, below the Landsburg Dam, and once the fishpass is constructed, will, with the exception of sockeye salmon as noted above, be able to recolonize the Cedar River above Landsburg Dam to approximately the lowest natural barrier of Cedar Falls, at about RM 34.2. The proposed instream flows would continue to exert an influence on the anadromous fish that inhabit the lower Cedar River while fish inhabiting the recolonized habitat would be subject to largely unregulated flows within those 12 miles of mainstem and 5 miles of tributary streams. Flow regulation in the newly accessible section of river would be limited to: (i) ramping rates (to be developed, but expected to be about 2 inches/hr) from the hydroelectric facility located at RM 33.7, and (ii) rearing flows of 30 cfs immediately below the natural falls, from RM 33.7 to 34.2.

6. Monitoring and Research

The monitoring and research program in the HCP includes: (1) compliance monitoring to determine whether HCP programs and elements are implemented; (2) effectiveness monitoring to determine whether HCP programs and selected elements result in the anticipated changes in habitat or other conditions for the species of concern; and (3) cooperative research to obtain more information on species of concern, test critical assumptions in the plan, and gain understanding needed to refine management decisions to meet plan objectives. The HCP also includes a commitment to adaptive management, which will be applied where considerable uncertainty exists and as a general mechanism for responding to new information that can be used to make conservation and mitigation strategies more effective.

Details of the conservation measures for each of the four major elements are described in Chapter 4 of the HCP. The following table summarizes the key measures of the HCP.

Table 2. Summary of minimization and mitigation measures

Subsection	Short name	Major measures included
Watershed Management Mitigation & Conservation Strategies		
<i>Ecological Reserve Conservation Strategy</i>	Reserve designation	<p>To protect key habitat, inclusion of all City watershed lands in Reserve:</p> <p>All mapped streams and wetlands Buffers on all mapped streams, lakes, ponds, & wetlands Inner gorges & headwalls (to prevent erosion and landslides) Sensitive soils (to prevent erosion & habitat damage)</p> <ul style="list-style-type: none"> _ All mapped riparian habitat _ Major wetland complexes _ Bull trout protection areas (for spawning and rearing)
	Reserve management guidelines	<p>Special management areas Buffers for unmapped or incorrectly typed streams & wetlands No timber harvest for commercial purposes Watershed assessment prescriptions Forest management guidelines Minimum road construction & other restrictions Salvage only for catastrophes</p>
	Habitat restoration	Restoration & ecological thinning, & restoration planting
	Reserve designation	<ul style="list-style-type: none"> _ All old growth, with buffers

Subsection	Short name	Major measures included
		<ul style="list-style-type: none"> _ Spotted owl CHU Older, low-elevation second growth Blocks of forest & other forest for connectivity
	Reserve management guidelines	Special management areas (adds closed forest; see under 4.2.4) No timber harvest for commercial purposes Watershed assessment prescriptions Minimum road construction and other restrictions Thinning <i>only</i> for habitat improvement Salvage only for catastrophes
	Habitat restoration	<ul style="list-style-type: none"> _ Restoration planting _ Restoration thinning _ Ecological thinning
	Reserve designation	Mapped talus, cliffs, & rock outcrops Meadows & persistent shrub Taylor town site (deciduous forest)
	Reserve management guidelines	Variable, operational buffers on all special habitats, depending on ecological significance
	Reserve administration	Ability to modify reserve boundary Restrictions on activities that could affect habitat and species
<i>Stream and Riparian Conservation Strategy</i>	Stream & riparian management guidelines	Operational restrictions for Reserve to protect aquatic & riparian habitats Strict standards for road construction, stabilization, & decommissioning to reduce landslides & erosion

Subsection	Short name	Major measures included
		Improved standards for road maintenance & repair
	Stream & riparian restoration	<p>To reduce sediment loading & produce net loss of road miles, road stabilization & decommissioning</p> <p>To restore stream connectivity, replacement of stream-crossing culverts that block fish passage</p> <p>To reduce sediment loading, replacement of stream-crossing structures that are inadequate for peak flows</p> <p>To reduce erosion into streams, stabilization of streambanks</p> <p>To restore natural functions of riparian forests, conifer underplanting, restoration thinning, & ecological thinning</p> <p>To improve stream habitats, placement of large woody debris in deficient stream channels</p>
<i>Controlled Public, Non-tribal Access to the Watershed</i>	Controlled, non-tribal, access	Current closure of watershed to unsupervised public access, providing protection from human disturbance, hunting & fishing mortality, & poaching
Minimizing and Mitigating the Effects of the Anadromous Fish Barrier at the Landsburg Diversion Dam		
<i>Conservation Strategies</i>	Interim: chinook, coho, & steelhead	<p>Either one or a combination of both:</p> <p>Population studies to support development of best long-term protection & rehabilitation measures</p> <p>Emergency artificial propagation (if needed for any species)</p>

Subsection	Short name	Major measures included
	Interim: sockeye	Extended funding of existing interim hatchery Evaluation of short-term rearing of hatchery fry
	Long-term: chinook, coho, & steelhead	<p>Fish ladders at dam & pipeline crossing at Landsburg, providing access to 17 miles of protected, refuge habitat in municipal watershed</p> <p>Fish sorting & holding facilities to allow separation of sockeye from other species & their return downstream.</p> <p>Downstream passage facilities for adult & juvenile fish at Landsburg Dam</p> <p>Fish screening & bypass facilities to prevent entrainment of juvenile (newly emerged fry through smolts) & adult salmonids into the water intake at Landsburg Dam</p> <p>Maintenance & operation of fish passage facilities</p> <p>Water quality monitoring for effects of salmon carcasses, to supply information allowing either an increase or decrease in number of fish allowed upstream; if a decrease, funding to be provided for alternative mitigation</p> <p>Monitoring of fish passage & screening facilities</p> <p>Measures for municipal watershed (see above)</p> <p>Instream flow protection between Lower Cedar Falls & Lake Washington, downramping prescriptions, & tailrace barrier at Cedar Falls hydroelectric project</p>
	Long-term: sockeye	Funding for construction & operation of fish hatchery

Subsection		Short name	Major measures included
			Funding for stream restoration projects below Landsburg Monitoring & research to determine effectiveness & effects of mitigation program
		Oversight & adaptive management	Oversight committee to advise City on mitigation Joint decision-making of City & federal & state agencies to adaptively manage hatchery & other mitigation, to ensure conservation objectives met
Instream Flow Management Strategy			
<i>Conservation Strategies for Instream Flow Management</i>		Stream flows below Landsburg	<p>Binding minimum flows in the Cedar River, based on extensive, cooperative studies, intended to benefit most life history stages of chinook, sockeye, coho, & steelhead as prioritized by interagency Cedar River Instream Flow Committee</p> <p>Annual instream flow pattern that reflects natural flow patterns & body of scientific information about Cedar River salmonids</p> <p>Instream flow regime & adaptive management designed to minimize conflicts among species</p> <p>Minimum flow commitments</p> <p>From early October through early August, flow commitments greater than or equal to flows required to provide maximum habitat (WUA) for key species & life history stages</p> <p>From early August through late September, commitments providing 98-99% of maximum WUA for steelhead rearing</p>

		<p>Flows greater than or equal to the level that provides maximum WUA for chinook and sockeye spawning for most of the fall</p> <p>Winter/spring flows to protect salmon redds from dewatering</p> <p>Summer block (volume) of water (2500 acre ft) in all normal years to protect steelhead redds</p> <p>Summer flows to protect rearing steelhead and coho</p> <p>Flows during drought years (critical flows) that provide protection for species</p>
	<p>Stream flows below Landsburg</p> <p>(continued)</p>	<p>Supplemental flows</p> <p>Additional block of water (3500 acre feet) during summer to reduce risk of steelhead redd dewatering in 70% of normal years</p> <p>Additional normal & critical flows for early spawning chinook & sockeye when overflow dike flashboards are in place</p> <p>High normal flows in at least 63% of all normal years for increased sockeye cumulative spawning habitat & edge habitat</p> <p>Increased flow for emigrating sockeye fry 70% of time from early February through mid-April in normal years</p>
	<p>Stream flows above Landsburg</p>	<p>Flows near or above levels that provide maximum habitat (WUA) between hydroelectric powerhouse at Cedar Falls & Landsburg Dam.</p> <p>Flows for rearing salmon & steelhead in (hydroelectric plant) bypass reach between Masonry Dam & powerhouse</p>
	<p>Flow downramping</p>	<p>Limited allowable flow downramping rates at Landsburg Dam, Cedar Falls Hydroelectric Powerhouse, & Masonry Dam to minimize risk of stranding juvenile salmonids</p>
	<p>Hydro facility improvements</p>	<p>Emergency bypass capability at Cedar Falls Hydroelectric Facility</p>

			to minimize impact of shutdowns Tailrace rack to exclude fish from turbine effluent pipes at Cedar Falls Hydroelectric Facility
		Ballard Locks improvements	Local match funding for feasibility study & implementation of project to save freshwater, aimed at improved fish survival Smolt passage improvements, increasing survival
		Permanent Dead Storage evaluation	Analysis of permanently accessing water below the natural outlet of Chester Morse Lake, potentially allowing both improved instream flows & increased water supply
		Flow studies	Studies to improve flow switching criteria Monitoring of steelhead redds to better protect incubating steelhead Accretion flow study in the lower Cedar River, with potential adjustment of flows if warranted Supplemental studies of potential biological effects of instream flows, to be designed, overseen, and interpreted by the IFOC, and that may be used to advise the City to better manage the IFA
		Flow oversight & adaptive management	– Cedar River Instream Flow Oversight Commission Agency participation in flow allocation decisions & response to study results in cooperative management model Real-time & long-term adaptive management, with cumulative learning and improved decision-making by City & Commission

C. Provision for Post-Termination Mitigation

Post-termination mitigation is an issue described in the Implementation Agreement, section 6.3, Permit suspension and revocation, and section 6.4, Relinquishment of the permit. In brief, post-termination mitigation could become an issue in this HCP in the event of early termination, by either the Services or the City, of the HCP and Permit.

The City is offering to continue to provide some conservation benefits to covered species in the event that the ITP is suspended or revoked before the end of the 50 year plan term, according to the following details described in the IA. If the ITP is suspended, revoked or relinquished, then the Services would determine whether any “take” of covered species that occurred during the term of the permit has not been substantially mitigated. If they determine that take has not been substantially mitigated, then they may require continuation of specified HCP activities until such time as mitigation is substantially completed. Substantial mitigation will have occurred if the mitigation that has been provided under the HCP at least compensates for the take that has occurred under the permit as of that date.

VI. ANALYSIS OF EFFECTS

A. Evaluating the Proposed Action

The standards for determining jeopardy are set forth in ' 7 (a) (2) of the ESA, and defined in the implementing regulations (50 C.F.R. ' 402). The NMFS also determines whether the proposed actions of issuing the ITP and signing the IFA and LMA would likely destroy or adversely modify critical habitat. This analysis will determine to what extent this action will likely affect each of the five species of anadromous fish addressed by the HCP and the riparian and aquatic habitats important to the anadromous salmon and trout. The NMFS jeopardy analysis considers how the proposed action is expected to directly and indirectly affect specific environmental factors that define properly functioning riparian and aquatic habitats essential for the survival and recovery of the species under consideration. This analysis considers the species biological requirements (Section III above) under the environmental baseline (Section IV above), and takes into consideration the overall balance of beneficial and detrimental activities taking place within the HCP, described above in Section V. If the effects of the action (described in Section VI) are found to jeopardize a particular species, then the NMFS could not approve issuance of the ITP for that species.

For NMFS to meet its obligation for consultation under section 7 (a) 2 of the ESA, the conservation measures of the HCP, including the flow regime proposed by the City in the Cedar River, must be assessed to determine whether the action of issuing an Incidental Take Permit would (1) reasonably be expected to, directly or indirectly, appreciably reduce the likelihood of both the survival and recovery of s listed species in the wild by reducing the reproduction, numbers, or distribution of that species, or (2) result in the destruction or adverse modification of designated critical habitat.

B. Effects of the Proposed Action

Five of the seven species of anadromous Eastern Pacific salmonids (*Oncorhynchus spp.*) occur within the HCP area and are addressed by HCP conservation measures. These fish have become adapted to cool, clean water, with abundant gravels and a diversity of habitats composed of riffles and pools. Because these salmonids have evolved in a largely forested setting, many of their adaptations are associated with cool water temperatures, high oxygen concentrations, and a complex substrate, e.g., an abundant supply of large woody debris (LWD) and a range of sediment sizes.

1. General Effects of Human Activities on Watershed Processes, Salmonids, and Their Habitats (excerpted from Spence, et al. 1996)

Land-use practices, including forestry, grazing, agriculture, urbanization, and mining can substantially alter watershed processes, resulting in degradation of streams, lakes, and estuaries. Logging and grazing affect the greatest percentage of lands in the Pacific Northwest, but the effects of agriculture, urbanization, and mining may result in a higher degree of local disturbance. Most of the alterations from land-use practices in upland areas result from changes in vegetation and soil characteristics, which in turn affect the quantity and routing of water, sediments, nutrients, and other dissolved materials delivered to streams. In addition, application of chemical fertilizers and biocides can affect water quality. Activities within the riparian zone can alter shading (and hence stream temperature), transport and supply of sediment, inputs of organic litter and large wood, bank stability, seasonal streamflow regimes, and flood dynamics. Dams, irrigation diversions, and road crossings hinder migrations, alter physical and chemical character of streams, and change the composition of stream biota. Harvest of salmonids reduces the abundance and alters the size- and age structure of populations. Introduced fish species can adversely affect native salmonids through competition, predation, and disruption of physical habitat. Similarly, hatchery-reared salmonids may have similar impacts as well as altering the genetic structure of populations through introgression.

2. Summary of HCP Beneficial and Adverse Effects on PS Chinook

Covered activities of the Cedar River Watershed HCP could affect anadromous fish in a variety of ways that are beneficial or adverse. Certainly, restoring access to 17 miles of protected watercourse within the municipal Cedar River Watershed would be beneficial since fish that inhabit those waters would encounter less human disturbance and greater influence from natural processes as they migrate, spawn and rear, compared to fish below the City lands. PS chinook would benefit from about 50% more mainstem river spawning habitat (12.4 additional miles of mainstem restored) compared to their available spawning habitat without the HCP conservation measures (21.8 miles). Compared to the existing regime of instream flows below the City lands, that same section of Cedar River under the IFA would be expected to have slightly improved conditions of instream flows for anadromous fish, because the IFA flows would be more tailored to seasonal conditions and have a greater assurance of additional flows during the times when supplemental flows are in place. PS chinook would particularly benefit from more water during their spawning period (i.e., from mid-September through December).

Adverse effects to PS chinook and other anadromous salmonids could occur from introduced sediment, degraded water quality, or unfavorable flow conditions resulting from: operations at the diversion dam (annual and emergency cleaning, and planned reconstruction); operations at the Cedar Falls hydro-electric facility; operations at the Chester Morse Reservoir or associated Masonry Pool; maintenance and repair of roads located near watercourses; or monitoring activities. Also, potential adverse effects to PS chinook and coho salmon that spawn commingled with the smaller-sized but often more numerous sockeye salmon include: (1) disease transmission, especially from Infectious Hematopoietic Necrosis virus (IHNV) from hatchery sockeye salmon, and (2) adverse interactions with spawning sockeye (e.g., disturbed redds, displaced chinook, or altered spawning behavior). Appendix 29 of the HCP is a NMFS memo that provides more detail of the potential effects of sockeye supplementation.

3. Watershed Management, Mitigation & Conservation Measures

Salmonids and riparian habitats are impacted by natural and anthropogenic disturbances (Spence et al. 1996). Some of the activities that cause these effects include: the construction of dams that block fish passage; the disconnection of channels from their associated floodplains by diking and other man-made structures; the removal or alteration of flows when it is likely to substantially impair spawning, migration, or other essential functions; the removal of riparian trees; the building and use of roads; and the effects of clearcuts and roads on watershed hydrology and potential to cause landslides.

The watershed management, fisheries mitigation, and instream flows described in the HCP and related agreements will likely result in improved salmonid habitat on City-managed lands. Watershed conditions will improve and become properly functioning for anadromous fish habitats as: deciduous and young conifer forests within riparian areas and throughout the watershed develop into older forests; the adverse effects of roads are reduced through comprehensive and site-specific road upgrades to restore fish passage at stream crossings and reduce likelihood of roads delivering sediment and water to streams; and, young forests on unstable hillslopes develop greater root strength and reach full hydrologic maturity (City et al., 1999a).

Under this HCP, the riparian areas within the watershed management would be allowed to grow and passively restore salmonid habitat. Since the entire watershed would have no commercial timber harvest, riparian areas are anticipated to develop into forest with old-growth characteristics, i.e. large old trees, multilayered canopy, and numerous snags and logs. Therefore, riparian areas will continue to provide increasing ecological functionality with respect to aquatic and riparian ecosystems that support anadromous fish habitats.

The specific functions of riparian ecosystem processes that influence the quality of freshwater salmonid habitat are thought to be: water temperature (i.e., shade along small channels), stream bank integrity, ameliorating delivery of sediments from surface and landslide erosion, detrital and dissolved nutrient load, and the delivery of large woody debris (LWD).

In spite of the highly conservative watershed management conservation measures under the HCP, slight, local adverse effects to salmonid habitat may continue to occur because some riparian forests have not fully recovered from the effects of past forest practices that occurred many decades ago along all of the lower watershed streams. The frequency and severity of any adverse effects will continue to decrease through the HCP term as forests develop structure and the road network is improved. The watershed conservation strategy, which includes active restoration of some riparian ecosystems and improvements to the road network, will serve to minimize and mitigate the adverse effects of past management and likely result in properly functioning conditions for fish habitats over the plan area within a few decades.

Monitoring for compliance will be conducted for watershed measures done by the City, as prescribed in the HCP (Section 4.5) but the highly conservative and proven measures do not warrant any monitoring for effectiveness or adaptive management.

a. Watershed Effects on Chinook, Coho, Steelhead, and Coastal Cutthroat Trout

The effects of past land management in the municipal watershed have included: (1) removal of riparian forest during timber harvest which reduced shade, altered the supply of food (invertebrates) to streams, and reduced recruitment of large woody debris; (2) construction and use of hundreds of miles of forest roads, which have blocked fish passage along some streams and increased sediment loading to streams through erosion and mass wasting (landslides). The current legacy of landscape disturbances in the majority of aquatic and riparian habitats in the municipal watershed presents opportunities for habitat rehabilitation and, over the long term, restoration of the natural ecological functions of the aquatic/riparian ecosystem.

Because no commercial timber harvest will be conducted in the watershed, all lands outside limited developed areas, including all aquatic and riparian ecosystem elements, are in reserve status. As a result, all key fish habitats within the municipal watershed (i.e., streams and associated riparian habitat in the lower watershed) is protected through reserve status. In addition, protection in reserve status of *all* forested areas of the watershed will decrease the likelihood of land management activities adversely affecting these fish species. In the short term, salmonids will benefit by increased levels of habitat protection and by active intervention to increase habitat complexity, such as through projects to add large woody debris to streams deficient in habitat structure. In the long term, salmonids will benefit from the different elements of the HCP designed to help restore a naturally functioning complex of aquatic, riparian, and upland forest habitats, so that the ecosystem itself can supply, on a sustained basis, the important habitat elements that are important to these species, such as woody debris that provides cover and creates pools.

Short-term and long-term gains in the quality of stream and riparian habitats are expected under the HCP as a result of the natural maturation of younger seral-stage forest in riparian areas. By placing all lands outside of limited developed areas in reserve status, the HCP includes provisions that will serve to protect and/or reestablish forest vegetation adjacent to streams in the lower municipal watershed, as well as protecting all wetlands, and their recharge areas, associated with streams. In addition, maturation of protected forest in riparian forests near streams will help restore more natural ecological functioning in the riparian/aquatic ecosystem as a whole, in part by restoring habitat complexity through natural recruitment of large woody debris, creation of more pools, increases in food production for fish, and cooler water temperatures.

The HCP also includes management actions designed to improve and help restore aquatic and riparian habitats, including stream bank stabilization projects; placement of large woody debris (LWD); a stream bank revegetation program; a program of restoration planting, restoration thinning, and ecological thinning in riparian areas; a program to eliminate, modify, or replace stream-crossing culverts that could impede the passage of fish using tributaries, restoring habitat connectivity and continuity; a program to eliminate, modify, or replace stream-crossing culverts that are inadequate for passing peak storm flows, reducing the chance of failure and resulting excessive sediment deposition in downstream habitat; programs to improve problem roads and the maintenance of roads that can affect streams, in both cases to reduce sediment loading to streams associated with erosion and mass wasting; and a program to decommission (remove) about 38 percent of forest roads (about 234 miles out of the total 615 miles of existing roads), further reducing sediment loading to streams.

Collectively, these conservation and mitigation measures would (1) help restore natural aquatic and riparian ecosystem functioning and (2) accelerate the development of mature or late-successional characteristics in younger second-growth forests in riparian areas. Although restoration of a more naturally functioning aquatic ecosystem will benefit salmonids over the long term, some of these management interventions may cause some localized, short-term decline in habitat function. Such impacts might include reduced canopy cover that could lead to increased solar heating of stream water or to increased rates of soil erosion, or disturbance of soils that could result in erosion and sediment release into streams.

Because no harvest for commercial purposes will occur in riparian areas, however, any impacts associated with the removal of vegetative cover will be largely eliminated. Site evaluations by an interdisciplinary team prior to undertaking such activities in riparian areas will also help minimize any such impacts on fish. In addition, the HCP also includes a comprehensive suite of Watershed Assessment Prescriptions (HCP Appendix 16) and other guidelines (HCP Section 4.2.2) intended to minimize the probability of erosion and mass wasting associated with silvicultural treatments in riparian areas. Implementing these prescriptions and guidelines will help reduce the rate of sediment loading to aquatic systems and will help maintain high water quality in potential habitats for anadromous salmonids.

The City believes that instream habitat improvement and rehabilitation must be accompanied by upslope protection and restoration that will reduce impacts of upslope conditions or activities on stream habitat. For example, efforts to stabilize stream banks or add large woody debris to streams may not be effective in the long run if road failures occur that result in large inputs of coarse sediment to streams upstream of such projects. Thus, these kinds of activities will be coordinated under the HCP.

Therefore, the net effects of watershed conservation measures upon PS chinook is expected to be beneficial, since fish will have restored access to habitats where natural processes are allowed to dominate.

b. Kokanee

The mitigation and minimization measures committed to in the HCP are expected to maintain the natural processes important for creating and maintaining habitat for kokanee in the watershed. The HCP is expected to result in short- and long-term benefits to kokanee as compared to the current conditions by implementing: (1) protection of all key habitat (Walsh Lake and its tributaries, and associated riparian habitat); (2) elimination of timber harvest for commercial purposes within the watershed, reducing the overall level of habitat disturbance; (3) protection of all riparian forest, as well as upland forest, with recruitment of substantial mature and late-successional forest over time in riparian and upland areas, improving the habitat quality of forests associated with the Walsh Lake and its tributaries; (4) silvicultural treatments designed to accelerate the development of natural functions in riparian forests and late-successional structural characteristics in second-growth forests; (5) stream restoration projects, which are expected to improve microhabitat conditions within the Walsh Lake subbasin; (6) road improvements and decommissioning, and improved road maintenance, reducing sediment loading to streams and other aquatic habitats; (7) guidelines and prescriptions designed to reduce sediment production during watershed management activities; and (8) monitoring and research.

Lands within the upper portion of the Walsh Lake Basin, including land around and above the lake, are owned completely by the City. Any effects of the HCP on kokanee habitat within the municipal watershed would be associated with land management. The effects of past land management in the municipal watershed have included: (1) removal of riparian forest during timber harvest, reducing shading, the supply of food (invertebrates) to streams, and recruitment of large woody debris; (2) construction and use of hundreds of miles of forest roads, which has increased sediment loading to streams through erosion and mass wasting (landslides); and particularly within the Walsh Lake Basin, (3) a history of homesteading and the existence of a mining and manufacturing community (Taylor) within the basin, which impacted forest and riparian vegetation, and water quality in the area (prior to City acquisition of the land).

Kokanee could be negatively affected by silvicultural treatments, road management, or other operational activities in riparian or upland areas that could affect Walsh Lake or its tributaries.

Such effects could be direct (e.g., through direct injury to or death of individuals) or indirect, through influences on habitat (e.g., removal of overstory riparian vegetation). Kokanee could also be negatively affected by management actions that may contribute sediment to aquatic habitats on a short- or long-term basis (e.g., stream habitat restoration projects, silvicultural treatments in riparian areas, road maintenance, use, and decommissioning).

In the short term, kokanee will benefit by increased levels of habitat protection and by active intervention to increase habitat complexity, such as streambank stabilization projects to reduce the frequency of bank failures. In the long term, kokanee will benefit from the different elements of the HCP designed to help restore a naturally functioning complex of aquatic, riparian, and upland forest habitats, so that the ecosystem itself can supply, on a sustained basis, the important habitat elements that are important to kokanee, including clean gravels for spawning.

Short-term and long-term gains in the quality of stream and riparian habitats are expected under the HCP as a result of the natural maturation of younger seral-stage forest in riparian areas. By placing all lands outside of limited developed areas in reserve status, the HCP includes provisions that will serve to protect and/or reestablish forest vegetation adjacent to streams and Walsh Lake, as well as protecting all wetlands, and their recharge areas, associated with streams. In addition, maturation of protected forest in riparian forests near streams and the Walsh Lake wetland complex will help restore more natural ecological functioning in the riparian/aquatic ecosystem as a whole, in part by restoring habitat complexity through natural recruitment of large woody debris, increases in food production for fish, and cooler water temperatures. Development of mature and late-successional forest significantly contributes to the reestablishment of a more naturally functioning ecosystem, thus benefiting kokanee in the Walsh Lake Basin.

The likelihood of direct take of kokanee resulting from land management activities is expected to be very low because of the specific mitigation and minimization measures committed to in the HCP: (1) interdisciplinary team site evaluations and protection of kokanee habitat prior to silvicultural or road management activities; (2) elimination of commercial logging activities (including virtually all log hauling) from the watershed; (3) compliance with Washington Forest Practice Rules; (4) the City's policy restricting unsupervised public access to the Cedar River Municipal Watershed, which minimizes potential mortality from fishing; and (5) removal of 38 percent of forest roads, which will reduce the potential for take related to road maintenance, improvement, and use over the long term.

Because of specific mitigation and minimization measures committed to in the HCP, as listed

above, the likelihood of disturbance to, direct injury to, or death of individuals as a result of silvicultural treatments, road management, or other operational activities in riparian areas is expected to be very low in any given year. The restriction of public access into the municipal watershed will provide benefits for kokanee by reducing potential disturbance and direct take that might result from fishing, although it is likely that trespassers fishing in Walsh Lake annually take a few kokanee.

c. Maintenance of Ecological Processes

A recent paper by Stanford et al. (1996) gives six elements of ecological restoration for regulated rivers: restoring peak flows; stabilizing base-flows; reconstituting seasonal temperature patterns; maximizing fish passage over dams; favoring natural habitat restoration instead of artificial fish propagation or artificial instream structures; and, adaptive ecosystem management. Conservation measures provided by the HCP and related agreements address many of these elements. In sum, the conservation measures aimed at ecological restoration will be expected to benefit PS chinook.

(1) Peak flows. The water supply system, including the water storage and supply operations of the City, has little capacity to influence peak flows. Under the proposed IFA and HCP watershed management, there likely would be no changes in the number or magnitude of potential floods in the watershed, the Cedar River downstream of the Landsburg Diversion, or Lake Washington. The natural hydrologic regime would continue to be restored as forests grow and many roads are upgraded or removed. The City's proposed watershed management activities would not directly affect surface water runoff in the 57% of the watershed that drains into the Cedar River above the reservoir, or the water level of Lake Washington. Consequently, there would be insignificant effects on flood flows downstream of Cedar Falls, Landsburg Diversion, or in Lake Washington.

(2) Floodplains. City lands along the Cedar River would be protected from any watershed management by undisturbed riparian areas, in areas away from already-developed sites. The currently altered floodplains of the lower Cedar would not be adversely affected by the proposed flow regime. As well, some of the lower river floodplains that have been identified as restoration opportunities (King County 1996) would be the focus of the five million dollars provided by the HCP for implementing habitat restoration projects, including groundwater-fed spawning channels, and the purchase and protection of lands adjacent to the river. The Cedar River below Landsburg has been impacted by urban development, channel modifications, reduction and harvest of riparian zones, and peak flow management practices (King County 1996). Mainstem and side-channel habitat quantity and quality have been reduced substantially compared to undeveloped conditions. King County has developed a Cedar River Basin and Non-Point Pollution Action Plan that includes recommendations for acquisition,

enhancement, or restoration of fish habitat, floodplain, or riparian areas in the lower Cedar River (King County 1996). The HCP proposes funding for projects selected by the signatories to the LMA. Specific projects to be implemented or properties to be acquired have not been identified at this time. King County would be an advisory member to each of the HCP oversight committees, so their expertise and recommendations would contribute to decisions about restoration projects.

(3) **Base-flows.** Mimicking the natural hydrologic patterns with the IFA would provide ecological benefits. While the instream flow conservation strategy considers natural hydrologic patterns, simply attempting to mimic general natural hydrologic patterns is overly simplistic and not entirely achievable within constraints of meeting firm water yield. As discussed in Section 4.4 of the HCP and in the response to General Comment #38 in the Response to Public Comments (City et al., 1999b), several features of the instream flow conservation strategy attempt to reflect the natural hydrologic patterns of the Cedar River. A wide range of streamflow pattern variation and fluctuations would exist in the Cedar River at Renton under the natural flow, i.e., calculated from the 64 year period of record by disregarding the effects of City water storage or withdrawals. Assured low flows in the IFA were designed to meet or exceed the calculated amounts of water (i.e., WUA) necessary for all life stages of the four key species of anadromous fish (CES 1991), including rearing and migration of Puget Sound chinook. Appendix 37 of the final HCP includes habitat duration analyses for various life stages of chinook coho, and steelhead that calculated the WUA compared to modeled unregulated flows.

(4) **Restoring stream temperature patterns.** Water quality is generally excellent in the 12.5 mile reach of the mainstem above Landsburg Dam due to relatively large inputs of cool, high quality groundwater and because much of this portion of the basin has substantially recovered after being intensively logged early in the twentieth century. Water temperatures downstream of the Landsburg Diversion Dam would be influenced mostly by the water temperature of tributaries in the lower water shed and the quality of the riparian habitat along the mainstem Cedar River between Landsburg and Lake Washington (City et al., 1999b).

Over the past few decades, an annual average of 72% of the instream flow at Landsburg Dam has not been withdrawn by the City but contributed to high water quality, including water temperatures favorable to anadromous fish, in the lower Cedar River (USGS 1992, cited in the HCP). This trend would continue under the proposed flow regime with slightly more amounts of cool water released to the lower river in the summer months in the times that supplemental flows are provided.

(5) **Fish Passage.** Passage of both adult and juvenile will be provided above the current limit to passage at Landsburg, as discussed above in the section Anadromous

Fish Mitigation. Chinook, coho, steelhead, and coastal cutthroat trout will regain access to 17 stream miles of reconnected, productive habitat that will be protected and restored as part of the watershed-wide Ecological Reserve and that will serve as a refuge within the Lake Washington basin for spawning, incubation, and juvenile rearing for the five species addressed in the HCP.

(6) *Natural Habitat Restoration.* The HCP provides opportunities for passive and active habitat restoration on both City lands and along the lower Cedar River. The commitment to fund habitat restoration in the lower river outside the City's ownership boundary will help restore natural river structure and function, and improve system buffering capacity by providing high-flow refuge areas for salmonid spawning, incubation, and rearing. The City's commitments to habitat protection and restoration, fish passage, and instream flows will substantially increase the quantity and quality of spawning and rearing habitat for Cedar River chinook, coho, steelhead and coastal cutthroat. Within the City's ownership boundary, stocks of these species will be provided the opportunity to rebuild through the processes of natural reproduction and production in a protected environment where natural biophysical processes are allowed to shape the structure and function of riparian and aquatic habitat. Recolonization of the habitat upstream of the Landsburg Dam will be expected to increase the resiliency and productive capacity of populations of chinook, coho, steelhead and coastal cutthroat (Winter 1990, cited in USDI 1995).

(7) *Adaptive Management.* The HCP describes specific elements of adaptive management in section 4.5.7. Detailed plans will be developed by the City for three particular parts of the HCP. Adaptive management is not prescribed for other elements of the HCP because the effectiveness of the set of conservation measures is well known from other studies (e.g., provision of riparian function) or the operational and economic limits of the City do not allow adaptive changes (e.g., changing the guaranteed HCP instream flows while maintaining firm water yield).

In all three cases, the issues entail monitoring or other studies related to outcomes about which there is uncertainty. In each case, there is a commitment to adjusting measures in the HCP based on the results of the studies or monitoring.

- The proposed flow regime will be adjusted if necessary as better information becomes available from a study of accretion flows downstream of Landsburg.
- Numbers of adult salmonids passed upstream over Landsburg Dam will be adjusted if necessary for water quality reasons.
- Monitoring and adjustable operation of the sockeye hatchery will be necessary to control

potential undesired impacts from hatchery fish upon other naturally spawning fish in the Lake WA basin. The monitoring and research program will provide useful information on Lake Washington sockeye salmon. It will help ensure the effectiveness of the conservation strategies, and will provide information that may be used to refine conservation measures, adapt them to changing conditions, and avoid and minimize risk.

4. Anadromous Fish Mitigation

a. Chinook, Coho, and Steelhead

Upstream and downstream passage facilities at the pipeline and Landsburg Diversion that would be constructed by the City by HCP-year 3 may have transient, adverse, local effects at the construction sites from the potential for introduced sediments and construction materials. There is a slight potential for long term effects, however, to accrue as LWD transport is interrupted by the diversion structure, although the City will evaluate the to-be-constructed floodway at the diversion dam as a means of passing LWD downstream in the future. But there will be long-term benefits to these species from the increased availability to spawning and rearing habitats in the Cedar River (12.4 miles) and certain tributaries (4.6 miles). The two ladders and associated sorting facilities will be designed for selective passage of coho, chinook, steelhead, and coastal cutthroat, but exclusion of sockeye. The potential for impacts to individual fish from operation of the sorting facilities is expected to be slight, based on operation of similar facilities at other locations (City et al., 1998, and Appendix 6 of the HCP). Since the selection process is non-random, there may be potential genetic impacts to the populations. The extent, severity, and likelihood of a potential impact, however, is difficult to determine, but is assumed to be negligible for PS chinook. Procedures will be developed by the CRAFC to put an appropriate sample of the run of each key species above the diversion dam.

An important objective for the City's anadromous fish conservation program is maintenance of a high-quality drinking water supply for the City of Seattle. An analysis by Ebasco (1988, cited in the HCP) suggested that water quality impacts could be substantial if sockeye were allowed above Landsburg. In addition, a more quantitative assessment by CH2M HILL (Appendix 5 of the HCP) indicated that current levels of total phosphorus and carbon would increase an estimated 0.81 percent and 0.12 percent, respectively, from 4,500 coho and 1,000 chinook (46,500 pounds total) passed above Landsburg Dam, but would be insignificant and difficult to detect under field conditions.

An estimated 12.4 miles of mainstem and about 4.6 miles of tributary streams will be restored to access by anadromous fish for the first time in almost a century. The benefits of passage

facilities at Landsburg Diversion are expected to be high because excellent fish habitat and water quality are present in the section of the watershed between Landsburg and Cedar Falls. To a large extent, this portion of the river is bordered by second-growth forest that was initially cut early in the century and is gradually returning to a late successional stage. Lands within the basin upstream of Landsburg are wholly owned by the City. Protection and improvement of conditions on these lands and streams are expected to be substantial as no commercial timber harvest would occur and many roads would be upgraded or removed. These conservation measures are expected to maintain or improve the existing habitat conditions (suitable water temperatures, more natural rates of fine sediment loading and transport, and increased instream large woody debris) in the Cedar River above Landsburg.

If the CRAFC decides that one of these species needs immediate attention, then efforts would be implemented for the protection and recovery of the populations. Before the fish ladders and screens are constructed, if one or more of these species are believed by the CRAFC to be declining towards extinction, the signatories to the Landsburg Mitigation Agreement can reallocate a portion of the investigation funds to be spent on an emergency supplementation program to help recovery of one or more of the stocks, prevent extinction or loss of genetic diversity, and provide supplementation monitoring (section B.2. of the LMA). Interim measures that are designed to increase knowledge of the factors affecting these species in the basin, or to provide emergency supplementation that would result in short-term conservation measures with a high likelihood of attaining the biological objectives stated above.

Any supplementation program will be limited in duration, meet NMFS ESA supplementation policies and guidelines, and not constitute a trade of habitat for hatchery production. Before a recommendation to supplement is made by the CRAFC, a determination will be made on the factors for decline, actions taken to address those factors, and the risk of extinction versus supplementation. A decision to supplement will be based on the likelihood that supplementation will lead to self-sustaining populations, as described in a recently proposed rule (65 FR 170). An example of one application of this approach can be found in the August 23, 1999 Section 7 Biological Assessment submitted by the USFWS to NMFS for the Hood Canal Summer Chum ESU.

In summary, the expected effects of these conservation measures described collectively under Fisheries Mitigation is likely to be beneficial to PS chinook.

b. Cutthroat Trout

When the fish passage facilities are constructed at Landsburg, expected to be operational by HCP year 3, these facilities will provide access to approximately 17 miles of mainstem and tributary stream habitat that will be protected and restored under the Watershed Management Mitigation and Conservation Strategies included in the HCP (Section 4.2.2). Accessible miles of mainstem habitat will be increased by 55 percent, and at least 5 miles of protected tributary habitat would be also available. The several tributary streams that enter the Cedar River between Lower Cedar Falls and Landsburg have high-quality habitat conducive to coastal cutthroat trout spawning and rearing. Improved access is expected to provide the opportunity for increased long-term natural production of coastal cutthroat trout in the municipal watershed.

It should be noted, however, that the tributaries of the mainstem Cedar in the lower part of the municipal watershed are currently occupied by large numbers of resident cutthroat trout, some rainbow trout, and hybrids in some areas, which will compete with any coastal cutthroat trout that enter the municipal watershed. It should also be noted that, if the cumulative impact of the HCP program results in large numbers of anadromous salmon within the municipal watershed, the resulting influx of marine-derived nutrients would enhance stream productivity and provide more favorable conditions for growth and survival of species like anadromous cutthroat that rear in the lower Cedar River or tributary streams in the municipal watershed for some portion of their lives. Preliminary results of Lake WA studies have found (E. Warner, MIT, pers. com., 1999) that cutthroat are primary predators on salmon fry, particularly of sockeye fry, so that pattern would be expected to continue as fish recolonize the Cedar River.

The likelihood of direct take of coastal cutthroat trout from land management activities is expected to be very low because of the specific HCP mitigation and minimization measures: (1) interdisciplinary team site evaluations and protection of coastal cutthroat trout habitat prior to silvicultural or road management activities; (2) elimination of commercial logging activities (including virtually all log hauling) from the watershed; (3) the City's policy restricting unsupervised public access to the Cedar River Municipal Watershed, which minimizes potential disturbance overall and substantially reduces fishing mortality; and (4) removal of 38 percent of forest roads, which will reduce the potential for take related to road maintenance, improvement, and use over the long term.

c. Artificial supplementation for sockeye salmon

(1) Potential Effects to PS chinook – In certain sections of the lower Cedar River, PS chinook spawn commingled with the smaller-sized but often more numerous sockeye salmon. PS chinook and sockeye have been sharing the spawning areas of the Cedar

River for about 50 years and no adverse effects have been observed from these interactions that need to be addressed at this time. Potential adverse effects of this inter-species interaction include: (1) disease transmission, especially from Infectious Hematopoietic Necrosis virus (IHNV) from hatchery sockeye salmon, and (2) local adverse interactions with spawning sockeye (e.g., disturbed redds, displaced chinook, or altered spawning behavior). Also, operation of the sockeye collection weir may delay migration or displace chinook spawners, as described below. There is no conclusive evidence for these potential effects to PS chinook actually occurring, but implementation of the LMA (section E.3.a.) will specifically look for these effects from sockeye supplementation and “avoid or minimize detrimental ecological impacts on native salmonids throughout the watershed.” Further, “If, based on the monitoring results, the Parties, in consultation with the Committee, conclude that certain components of the program implementation are not meeting program objectives (stated in paragraph E.3.a, above), then the Parties, by agreement, may alter the program to meet those objectives, provided such alterations do not result in expenditures earlier than provided for nor change the total dollar amount allocated to the sockeye salmon mitigation program.” (LMA, section E.3.e.) Therefore, potential adverse effects to PS chinook from sockeye supplementation are expected to be slight.

Note that interspecies interactions of naturally spawning fish would not be addressed by the LMA implementation or monitoring. Management of naturally spawning fish outside the City lands is not an HCP covered activity, but may be discussed by fishery co-managers within the CRAFC.

(2) *Potential effects to sockeye.* There is an extensive discussion of the expected and potential effects of the sockeye supplementation program in the EA (section 4.4.2), and the Technical Appendix 29, which are herein incorporated by reference. Following is a summary of key points.

Four objectives have collaboratively been established for the sockeye fry-production program. First, the sockeye fry-production program should be designed to produce up to 34 million fry (in order to meet the State Senate Bill 5156 passed in 1989). Second, the program should be designed to produce fry that are equivalent in quality to those that are produced naturally. Third, the program should avoid or minimize detrimental impacts on the reproductive fitness and genetic diversity of naturally reproducing sockeye salmon populations in the Cedar River and Bear Creek sub-basins. Fourth, the program should avoid or minimize detrimental ecological impacts on other native salmonids throughout the Cedar River watershed.

Because the presence of large numbers of spawned-out carcasses creates an unacceptable risk to drinking water quality and public health (see Appendix 5 of the HCP), an artificial propagation program is provided as an alternative solution to mitigate for the lost sockeye salmon production

capacity upstream of the Landsburg Dam. Note that of all the species of anadromous fish, sockeye alone have the potential to contribute large numbers of spawned-out carcasses in any one season, so those fish would be excluded from access above Landsburg as noted in the section above, Minimizing and Mitigating the Effects of the Anadromous Fish Barriers at the Landsburg Diversion Dam. The City will construct a sockeye hatchery with the capacity to produce up to 34 million emergent sockeye fry per year. The program will employ recently developed sockeye culture techniques, as further refined during prototype testing at the Landsburg interim hatchery, to help ensure the production of robust, disease-free fish.

The artificial propagation program for sockeye salmon will provide an incubation refuge, increase fry recruitment from the river, and help ensure that adequate numbers of adult fish return to spawn naturally in the river. Supplemented fry production will be designed to increase the capacity of the population to maintain itself when challenged with adverse environmental conditions (i.e., flood-scour or droughts), while avoiding and minimizing risks to naturally reproducing salmonids.

The biological rationale for a hatchery is straightforward, but there are several possible negative effects, e.g., interactions with naturally spawning sockeye or other species that result in reduced productivity or reduced genetic fitness in populations. Recognition of these possible negative effects allows the development of monitoring and procedures to minimize or avoid them (Appendix 29). A key point of adaptive management for this HCP is the monitoring and operation of the sockeye hatchery needed to control undesired impacts on wild fish and to determine effectiveness in helping to meet long-term goals for harvestable runs, with provision for altering hatchery operations or developing alternative mitigation, as provided for in the LMA, section E.3. At least one year prior to initial operation of the final sockeye hatchery, the City will develop and present in a document an approach that includes the following elements and criteria:

- A general monitoring and/or research plan based on explicit hypotheses, the biological objectives described in this HCP, and the appropriate research and/or monitoring plans described in Section 4.5 of the HCP;
- Threshold criteria for triggering additional or changed mitigation;
- Limits to the type of and commitments to any long-term mitigation triggered by monitoring criteria;
- A procedure for dispute resolution over interpretation of results consistent with dispute resolution procedures specific to the relevant agreement; and

- A process for developing and implementing any additional mitigation for which the need is demonstrated and that clearly identifies the responsibilities of the parties involved.

A number of sources have detailed the problems associated with the misapplication of artificial propagation in the past and have cautioned against the continued misuse of this approach in the future (Hard et al. 1992; Hilborn 1992; NRC 1996; Reisenbichler 1997; WDFW 1997b; all cited in the EA). WDFW's experience with anadromous and resident fish stocks has shown that the risks of artificial propagation must be carefully considered. Negative effects of hatcheries, primarily on naturally reproducing coho, chinook, and steelhead stocks in many areas of the state, have contributed to the development of the Washington State's Wild Salmonid Policy. This policy represents a dramatic change in the state's management direction and emphasizes the protection and rehabilitation of naturally reproducing fish stocks (WDFW, 1997). The discussion in the EA presents these risks in detail and describes risk reduction techniques to be implemented for the use of a hatchery to increase sockeye fry production.

The benefits that may be derived from a sockeye fry hatchery result primarily from increases in egg to fry survival. This increased survival will help compensate for the lost sockeye potential production capacity upstream of the Landsburg Diversion Dam. In addition, incubating sockeye are particularly vulnerable to mortality resulting from increased bedload scour during high flow events. During high flow events, the largely confined channel in the lower river results in increased water velocity, increased energy, and subsequent increases in bedload movement. Egg to fry survival in the Cedar River subsequent to the 2-year flood event is typically much lower than 10 percent (Seiler and Kishimoto 1997, cited in the EA). In contrast, egg to fry survival within a hatchery can exceed 90 percent. Because egg to fry survival is an important factor that contributes to fish productivity early in the life history, the difference in survival rates means a hatchery can increase the overall productivity of the stock. Based on preliminary results of adult returns from marked pilot hatchery sockeye fry, the number of fry released from the hatchery can represent a significant portion of the total sockeye fry produced in the Lake Washington Basin.

Extensive use of hatcheries during this century has shown there are risks that less-than-expected adult production and negative effects to nearby naturally reproducing stocks can occur (NRC 1996). These risks can be grouped under six general issues: genetics and domestication; disease; water use and quality; effects of straying on naturally reproducing stocks; effects of harvest on naturally reproducing stocks; competition with naturally reproducing stocks for limited resources; and, other ecological effects on salmonids other than sockeye, including chinook and steelhead.

Although considered by the state as a wild stock (naturally reproducing), the introduced Cedar River sockeye population has been determined by NMFS to not be a species for consideration for protection under the ESA (63 FR 11750). However, the sockeye stock present at the north end of Lake Washington in Bear Creek, a tributary to the Sammamish River, is potentially of native origin (63 FR 11761) and may someday warrant designation and protection as an ESU. Continued enhancement of the sockeye population on the Cedar River could potentially impact the Bear Creek population through straying of Cedar hatchery fish into Bear Creek at spawning times. The extent to which this impact may have already occurred is unknown, and otolith observations, which have not been yet been reported for fish collected in 1998 and 1999, will provide the first data. Design of the adaptive management plan for sockeye hatchery operation and effectiveness by the CRAFC will address the recommendations provided in the NMFS memo in Appendix 29.

Section 4.3.2 of the HCP describes details of the strategy to implement the sockeye mitigation program that are intended to minimize effects of this program on naturally spawning anadromous fish in the Lake Washington basin. The multi-agency HCP Oversight Committee and Anadromous Fish Committee will include fisheries resource managers to assure that new information is incorporated into future decision making.

The City recognizes that, while the sockeye fry production program offers potential benefits for the population, it also entails a level of uncertainty and risk. As part of the sockeye mitigation program, the City intends to implement measures to manage risk and uncertainty first, through rigorous pre-project planning and operational guidelines, and second, through implementation of an effective monitoring and adaptive management program (see Kapuscinski and Miller 1993; Kapuscinski 1997, cited in the HCP). These provisions will minimize genetic risks to the naturally reproducing, introduced population of sockeye in the Cedar River. The Bear Creek sockeye population in north Lake Washington has been classified as a provisional ESU by NMFS and is not presently considered at risk of extinction (NMFS 1997). In the absence of specific information for potential interactions of Cedar River hatchery sockeye with Bear Creek sockeye, NMFS considers the proposed hatchery program to pose a moderate level of genetic risk to the Bear Creek population (Appendix 29). The City, in consultation with NMFS and the CRAFC, will strive to minimize the genetic risk to Bear Creek sockeye by (i) establishing thresholds for the rate at which Cedar River hatchery sockeye stray into the Bear Creek system, (ii) monitoring the actual incidence of spawning Cedar River hatchery fish in Bear Creek and, if necessary, (iii) implementing corrective measures such as reduced production levels and improved fry release strategies to reduce straying. By including HCP signatories, other stakeholder groups and technical experts in the CRAFC, the City expects to bring to bear the best available science to adaptively manage risk and uncertainty associated with the artificial production program.

(3) Operation of the sockeye collection weir. An adult fish collection weir across the Cedar River, located at RM 6.5, has been operated as part of the pilot sockeye hatchery for the past several years and would be expected to continue operating yearly to collect adult spawners for hatchery brood-stock as part of the HCP sockeye production program. Modifications of the design and operational protocols of the weir, however, are being developed by the Cedar River Sockeye Technical Committee (CRSTC) to reduce the chances that brood-stock collection activities will have a negative impact on spawning and incubating chinook.

Although there is some information collected by King County that weir operations may have altered timing or local distribution of spawning chinook in the Cedar River during some of the past eight years that the weir has operated, fishery managers don't know if ongoing brood-stock collection activities associated with the present interim sockeye hatchery have had significant detrimental impacts on salmonid reproduction in the Cedar River. The new protocols being developed for weir operations are intended to reduce potential negative impacts on chinook.

The design and implementation of improved sockeye broodstock practices, including the weir operation protocols, will be addressed during the planned development of sockeye mitigation program guidelines in Year 1 of the HCP. Interim and long-term broodstock collection facilities will be designed and operated in a manner that avoids and minimizes potential negative impacts on naturally reproducing fish in the Cedar River. Specific aspects of the long-term broodstock collection program will be further addressed during project specific environmental review prior to initiating construction of a final facility. As part of the HCP, the City will commit \$200,000 specifically earmarked for research to support the development and implementation of effective sockeye broodstock collection facilities and practices to minimize the risk of detrimental effects on naturally reproducing salmonids in the Cedar River. Therefore, expected effects to PS chinook of operating the sockeye collection weir are expected to be slight to negligible.

(4) Interim Fish Screen Potential Impacts. Before fish passage improvements are made at Landsburg, some resident fish that naturally move downstream at Landsburg, e.g., coastal cutthroat or rainbow trout, but not PS chinook, could be injured as a result of impingement on the water intake screens at Landsburg, or crossing the Landsburg Diversion Dam. HCP improvements for fish protection, however, include new intake screens and modifications to the dam designed to minimize such impacts. Because the new fish screens and dam modifications committed to in the HCP will be operating by as soon as 2002, and no later than 2009, it is unlikely that disturbance to, direct injury to, or death of individuals as a result of operation of the Landsburg facilities will have any effects with population-level consequences. Habitat Restoration and Protection Downstream of Landsburg.

d. Habitat Restoration and Protection Downstream of Landsburg.

The expenditure of nearly \$5 million dollars for downstream habitat restoration and protection has a range of potential results, based on the number and location and types of projects. Habitat restoration and protection projects downstream of the Landsburg Diversion Dam have been suggested as possible ways to completely, or at least partially, fulfill the City's mitigation goals for sockeye salmon. As discussed in Chapter 2 of the EA, any project proposal that uses downstream habitat restoration projects as a component of a mitigation program for sockeye is subject to the approval of WDFW, pursuant to state law. As well, habitat restoration projects off City lands and subject to the authority of the ACOE will likely have the potential for affecting ESA species, and would therefore result in section 7 consultations with NMFS.

As discussed below, there is a great deal of uncertainty in estimating fry production values from habitat restoration projects. Therefore production numbers are discussed in terms of a range of values. Even under the best of circumstances these production values may not be achieved every year because of many factors, and the vast majority of potential habitat projects would be on private land and sites that have yet to be investigated in depth.

The HCP provides nearly \$5 million to implement habitat protection and restoration projects in the lower river downstream of the municipal watershed. The Cedar River watershed below Landsburg has been impacted by urban development, channel modifications, reduction and harvest of riparian zones, and peak flow management practices (King County 1996). Mainstem and side-channel habitat quantity and quality have been reduced substantially compared to undeveloped conditions. In addition, these changes have, by altering the routing of stormwater and diking the channel and floodplain, increased the frequency of scour events that could negatively affect sockeye redds. Habitat restoration and protection projects downstream of the Landsburg Diversion Dam can help reverse this trend and provide further benefits to sockeye.

A range of habitat protection and restoration projects has been identified as candidates for future implementation in the Lower Cedar River (King County 1996). Likely projects include riparian habitat acquisition and protection, and reestablishment of groundwater-fed side channels and ponds in the floodplain. These types of projects likely all require permit approvals by the ACOE, which in turn would trigger ' 7 consultation by the Services. If groundwater-fed channels and ponds are constructed, spawning and incubation conditions for sockeye are likely to improve

significantly. These types of restoration and enhancement projects take advantage of the available groundwater by digging channels, modifying old stream meanders or side channels, or adding clean graded gravel (Althausen 1985, cited in the EA). An important feature of groundwater-fed spawning channels is the protection of redds from scouring flows (Althausen 1985, cited in the EA).

Habitat protection and restoration directly in or along the mainstem may provide less direct benefits for sockeye, but would nevertheless help protect structural and functional habitat elements that are used by sockeye for upstream migration and for spawning. Protection and restoration projects in tributaries can also provide direct and indirect benefits for sockeye, however the benefits of these projects are more difficult to predict and will vary depending upon the type and location of each particular project.

Therefore, expected effects to PS chinook of habitat restoration projects below Landsburg are expected to range from neutral to largely beneficial.

e. Interspecies interactions

Interspecies conflicts can potentially occur when implementing mitigation measures for the effects of the Landsburg Dam. The need to sort sockeye from upstream migrating chinook and coho as they pass over upstream fish passage facilities in the future may result in increased handling stress for adult salmon that must be captured and transported back downstream.

An increase in sockeye fry production due to the proposed sockeye mitigation program could potentially lead to an increase in potential predator populations in the river that may also prey upon chinook and coho fry which overlap with sockeye in their emergence timing. Conversely, short-term increases in sockeye fry abundance could serve to overwhelm predators during parts of the year and thus reduce predation rates on other species. An increase in sockeye fry abundance could also result in an increase in the forage base for yearling steelhead and coho and thus provide benefits to these species. An increase in the number of spawning sockeye could potentially affect spawning chinook. This potential effect is expected to be minimal because chinook that are larger than sockeye tend to select somewhat different spawning habitat and generally bury their eggs deeper in the gravel than do sockeye. An increase in the number of adult steelhead returning to spawn could result in the disruption of a larger number of chinook and sockeye redds late in the incubation season. Since chinook tend to complete incubation in April, well before the completion of sockeye incubation, spawning steelhead are more likely to

disturb incubating sockeye than incubating chinook. Therefore, expected adverse impacts of interspecies interactions to PS chinook are expected to be slight.

f. Effects of Changes to the Ballard Locks

The Ballard Locks have been identified as a significant source of mortality to emigrating anadromous salmonids (City et al., 1999). The HCP provides funds to support implementation of passage improvement measures currently under consideration by the ACOE. The ACOE estimates that full implementation of these measures will substantially increase passage survival (ACOE 1997, cited in the EA). The expected increased survival of smolts of all species of salmonids passing through the Ballard Locks will increase the productivity of anadromous stocks within the Cedar River and throughout the Lake Washington Basin.

The HCP contributes funds for fish passage improvements and improvements to the salt-water drain at the locks (or other measures to conserve freshwater). The saltwater drain is designed to help manage and reduce the accumulation of salt water that passes into Lake Union during normal operation of the locks. This system uses a considerable amount of freshwater to manage saltwater intrusion. These improvements are expected to save approximately 6,000 acre-feet of fresh water each year, which could then be allocated for other beneficial uses, such as to improve fish passage flows at the locks. Therefore, expected effects of improvements in water management and fish passage at the Ballard Locks are expected to be beneficial for PS chinook.

A series of actions is expected to be proposed by the ACOE over the next several years to address improvements of fish passage at the locks. Some of these proposed actions may affect listed fish (PS chinook) and will thus become section 7 consultations with NMFS.

g. Effects of the sockeye fishery on PS chinook and other species

One of the major objectives of the City's mitigation plan for sockeye salmon is to contribute to the development of a viable tribal and sport fishery in Lake Washington. As described under the sockeye salmon effects section, the HCP has the potential for greatly increasing adult sockeye returns available for harvest. The potential problems associated with a mixed-species fishery for sockeye (see HCP Section 4.3.2) are not considered a concern for coho salmon and steelhead trout because significant numbers of adult fish are not present in Lake Washington during the period in which sockeye salmon harvests are conducted. Some portion of the chinook run is present in the lake during the sockeye harvest. However, many chinook enter the lake after the period during which sockeye harvests are traditionally conducted. Harvest reports from past sockeye sport fisheries in Lake Washington indicate that very few, if any, chinook have been

harvested. In addition, gear restrictions and mandatory release requirements can be imposed to further limit the effects of any incidental chinook capture. Inclusion of the fishery co-managers on the HCP Anadromous Fish Committee is expected to expedite resolution of potential fishery conflicts. Therefore, the expected level of adverse impacts to PS chinook from the sockeye fishery is assumed to be slight.

h. Summary of Effects of the HCP to Coastal Cutthroat

The combination of mitigation and minimization measures committed to in the HCP is expected to protect coastal cutthroat trout within the municipal watershed. Additional benefits will be provided by the instream flow regime, funding for protection and restoration of habitat downstream of Landsburg, and construction of fish passage facilities at Landsburg. The likelihood of direct injury to, or death of, any coastal cutthroat trout resulting from silvicultural treatments, road management, or other operational activities is expected to be very low under the HCP, although some fry or juvenile coastal cutthroat trout could be stranded during flow downramping events, and some juveniles be injured by impingement on the water intake screens at Landsburg, should any spawning occur above Landsburg.

The mitigation and minimization measures committed to in the HCP are expected to maintain the natural processes important for creating and maintaining habitat for coastal cutthroat trout in the municipal watershed and downstream, to the extent the City can influence downstream habitat. The HCP is expected to result in short- and long-term benefits to coastal cutthroat trout as compared to the current conditions by implementing or providing:

- construction of fish passage and protection facilities at the Landsburg Diversion Dam;
- implementation of guaranteed and supplemental instream flows, protecting and providing habitat in the Cedar River below the Masonry Dam and including protection of redds;
- protection of juveniles fish from stranding during flow downramping events;
- funding for habitat protection and restoration downstream of Landsburg;
- funding to improve survival of smolts passing through the Ballard Locks to Puget Sound;
- adaptive management of river flows, through the Cedar River Instream Flow Oversight Commission;
- protection of all key habitat in the municipal watershed (streams and associated riparian habitat between Lower Cedar Falls and Landsburg);
- elimination of timber harvest for commercial purposes within the watershed, reducing the overall level of habitat disturbance;

- protection of all riparian forest, as well as upland forest, with recruitment of substantial mature and late-successional forest over time in riparian and upland areas, improving the habitat quality of forests associated with streams and helping to restore natural ecological functions in riparian forests;
- silvicultural treatments designed to accelerate the development of natural functions in riparian forests and late-successional structural characteristics in second-growth forests;
- stream restoration projects, which are expected to improve microhabitat conditions in many reaches;
- road improvements and decommissioning, and improved road maintenance, reducing sediment loading to streams and other aquatic habitats;
- guidelines and prescriptions designed to reduce sediment production during watershed management activities; and
- monitoring and research.

Coastal cutthroat trout could be negatively affected by impingement on water intake screens at Landsburg (after fish ladders begin operating), management of instream flows, silvicultural treatments, road management, or other operational activities in riparian or upland areas that could affect streams or riparian habitats in the municipal watershed (also after fish ladders begin operating). Such effects could be direct (e.g., through direct injury to, or death of, individuals) or indirect, through influences on habitat (e.g., removal of overstory riparian vegetation). Coastal cutthroat trout could also be negatively affected by management actions that may contribute sediment to aquatic habitats on a short- or long-term basis (e.g., stream habitat restoration projects, silvicultural treatments in riparian areas, road maintenance, use, and road decommissioning).

If there are currently coastal cutthroat trout in the Cedar River, they can be expected to colonize the habitat above the Landsburg Diversion Dam after fish passage facilities are provided under the HCP. Access to the upstream habitat will contribute significant benefits for coastal cutthroat trout if other factors outside the watershed do not limit the population. Anadromous coastal cutthroat will have access to the mainstem Cedar River below Lower Cedar Falls and the lower portions of Rock, Williams, and Steele Creek sub-basins. Juveniles in other rivers typically rear for about one year in their small, natal streams, then move into larger streams for several years before emigrating to salt water.

It is most likely that coastal cutthroat trout would spawn and rear in tributaries to the Cedar River, not the mainstem, but some juveniles could utilize the mainstem. General field observations indicate that rainbow trout strongly predominate in the mainstem Cedar within the

municipal watershed at present, with a ratio of about 99 rainbow to 1 cutthroat observed during trapping in the 1970s (Casne 1975, cited in the HCP). The mainstem would be used for migration by all adults and smolts, however, and it could be used by a small number of adults for spawning and by some juveniles for rearing. Construction of fish passage facilities at Landsburg will substantially increase the availability of protected, high quality habitat for spawning adults and rearing juveniles.

The primary provisions in the HCP that will enhance conditions in the Cedar River Basin for coastal cutthroat trout include: (1) proposed guaranteed flows and change of the flow compliance point; (2) flow downramping standards to protect juvenile fish from stranding; (3) funding for habitat protection and restoration projects, potentially including groundwater-fed spawning channels and the protection and/or purchase of lands near the river downstream of Landsburg; (4) construction of fish passage and protection facilities at the Landsburg Diversion Dam; and (5) watershed management mitigation and conservation measures that would benefit any coastal cutthroat trout present in the municipal watershed once fish passage is restored. These measures are expected to provide immediate protection of coastal cutthroat trout habitat and provide opportunity for increased production in the basin.

The lower Cedar River downstream of the Municipal Watershed has been severely impacted by urbanization and other development, channel modifications, and riparian zone disturbance (King County 1996). Mainstem and side-channel habitat quantity and quality have been reduced substantially compared to original conditions in the lower river largely by land management actions beyond the control and responsibility of the City.

The HCP provides \$4.6 million for habitat protection and improvement downstream of Landsburg, which could potentially include construction of groundwater-fed spawning channels and the protection and/or purchase of lands adjacent to the river or its tributaries, which should benefit coastal cutthroat trout. New groundwater-fed side channels would provide perennial habitat protected from channel scour associated with peak flows in the main channel of the Cedar River, and some could be used by coastal cutthroat trout.

5. Effects of Instream Flows

Altered instream flow conditions resulting from flow-regulated rivers can affect anadromous fish in a number of ways, depending on the species' life stage, time of year, degree of variation from unregulated flows, and associated changes in sediment transport and water quality (Bovee 1998, NRC 1996).

The operation of the City's water storage, diversion facilities, and hydroelectric generating plant directly affects the quantity and quality of fish habitat in the Cedar River and Chester Morse Lake. Stream flow regulation can affect a number of factors that influence anadromous salmonid production potential downstream of the Lower Cedar Falls. The volume of water, or instream flow (generally measured in cubic feet per second, cfs), flowing through the stream channel can affect the amount and distribution of spawning and rearing habitat in the river at any given time; affect survival of incubating eggs or larval fish; affect the risk of stranding fish during reductions in flow; and can affect conditions for upstream and downstream fish migration. In addition, fluctuations in reservoir levels associated with water storage and withdrawal can affect fish populations resident to Chester Morse Lake.

a. General Effects

The HCP guaranteed and supplemental flow regime is summarized in the HCP (Table 4.4-1) and IFA. The relationships between guaranteed flows, the existing non-binding IRPP minimum flows and the flows that provide maximum WUA for key species and life stages as determined by PHABSIM analyses are summarized in HCP Figures 4.4-2 through 4.4-5. Expected actual flows will often exceed guaranteed flows during the fall, winter and spring because: (i) inflows to the basin often exceed amounts required to meet the guaranteed flows and municipal water supply demands; (ii) surface runoff in the lower 57% of the basin enters the Cedar River naturally and is not influenced by the water storage reservoir; and, (iii) flood storage capacity in the reservoir is relatively limited. Expected actual flows under the HCP instream flow management regime, under the existing IRPP regime, and under natural unregulated conditions are summarized in Appendix 36 Appendix 37 provides habitat duration analyses for expected actual flows under the HCP, IRPP and natural flow regimes using PHABSIM output for key species and life stages.

For most of the year, HCP guaranteed flows are higher than existing IRPP minimum flows and higher than the flows required to provide maximum WUA for key species and life stages. Although these higher flows result in a reduction in WUA when compared to the flows that maximize WUA, they will help ensure that the guaranteed regime more closely mimics natural basin hydrology and will provide a variety of important overriding biological benefits that are discussed later in this section.

b. Existing Instream Flow Regime Effects

The existing non-binding instream flow regime is based on the Western Washington Instream Resource Protection Program (IRPP), established by WDOE in 1979. In addition to the IRPP,

the existing flow regime includes flow adjustments favorable for fish that have been discussed at several periods each year, since about 1994, by representatives of the City, WDOE, WDFW, the Muckleshoot Tribe, and sometimes FWS and NMFS. Species' effects of the existing flow regime are discussed in the EA, section 4.4.3. Concerns center on steelhead spawning and incubation flows, chinook outmigration, early-spawning chinook, coho and steelhead rearing in mid-to late-summer, and optimizing sockeye spawning in channel margins away from flood-scour. Despite these concerns, there is no evidence that the existing flow regime routinely impacts anadromous fish in the Cedar River to the point that significant fractions of any life stage or population are "harmed," according to the NMFS definition of "harm" (64 FR 60727). But natural variations in flows outside of the City flow regime in the lower Cedar River below Landsburg can result in flow extremes that are not favorable to survival of individual anadromous fish (City et al., 1999a).

c. Enhancements of the Existing Instream Flow Regime

In addition to providing a regime that is more similar to the natural hydrologic regime, the HCP instream flow strategy will provide many specific prescriptions and safeguards, none of which exist under the present management regime, to improve conditions for Cedar River anadromous fish. These commitments have been developed with an extensive information base that has been developed collaboratively with state, federal, and Tribal resource managers over the last 10 years. The primary improvements provided by the HCP instream flow regime over existing conditions are summarized below.

- Binding minimum flow commitments, where none presently exists, that provide more water and better habitat conditions throughout the river between the natural anadromous fish migration barrier at Lower Cedar Falls and Lake Washington;
- supplemental flows that provide additional water above minimums, as conditions allow, to further improve anadromous fish habitat;
- downramping prescriptions to constrain the rate at which flows may be reduced in the Cedar River and therefore limit the risks of stranding juvenile fish;
- relocation of the flow measurement point for increased operating precision, better protection of habitat in the upper reaches of the lower river and a more natural hydrologic pattern;
- the provision of rearing flows in the bypass reach between Lower Cedar Falls and the Cedar Falls hydroelectric facility; and
- funds to support improvements in downstream fish passage and water use efficiency at the Ballard Locks.

d. Summary of Flow Effects on PS chinook and other fish species

The results of the comprehensive IFIM study and other collaborative studies have been used as the foundation for this effects analysis. Development of the HCP flow regime considered the degree to which the maximum habitat availability for species and life history stages throughout the year are achieved, as determined by IFIM. IFIM is an important and powerful tool that is helpful in describing the relationship between stream flow and fish habitat and is the accepted methodology in Washington State used to establish instream flow requirements for fish. However, it is recognized the methodology does not address all aspects of the biological requirements of fish (Castleberry et al., 1996). Therefore, the flow regime was developed to help provide for other key factors of habitat quality as identified by the CRIFC and described by the companion investigations conducted during the collaborative study program.

The discussion of the specific effects of the HCP flow regime centers around the timing of key life history stages for the four anadromous salmonids as described in Figure 1. From September 23 through May 12, the HCP minimum flows will, on average, be well above the flow levels that provide maximum WUA for key life history stages of all four anadromous fish species as determined by the collaborative IFIM studies. As flows increase above the level required to provide maximum WUA, water depths and velocities in much of the stream channel increase beyond suitable levels and the total amount of spawning and rearing habitat generally decreases. However, the increased flows will provide a variety of substantial benefits that improve quality of spawning, incubation, and emigration habitats for PS chinook and other species of salmon.

From May 13 through June 16, the HCP minimum flow commitments slowly decline in a pattern that follows the shape of the natural hydrograph and will, on average, be slightly lower than existing flows. These lower flows provide more WUA for steelhead spawning and juvenile steelhead, coho, and chinook rearing than the existing flow regime.

From late June to August 4, the HCP minimum flow commitments will generally be greater than the existing flows. The actual flows during this period will vary from year to year as prescribed by the CRIFC to provide protection of incubating steelhead. However, throughout this period, the elevated flows will be greater than the flows required to provide maximum WUA for steelhead, coho, and chinook rearing and will generally result in a small reduction in juvenile rearing habitat. From August 5 to September 15, the HCP minimum flow commitments are slightly below the levels required to provide maximum WUA for juvenile salmonids.

(1) Fall Flows. As substantial numbers of adult chinook and sockeye salmon begin to enter the Cedar River by mid-September, considerations for

juvenile rearing conditions become secondary to considerations for sockeye and chinook spawning. By mid-September minimum flow commitments increase beyond the levels that provide maximum WUA for coho and steelhead juvenile rearing. However, the resultant losses in rearing habitat associated with these increased flows are moderate and are not believed to pose a threat to the populations. By the middle of September, the HCP flows are greater than required to provide maximum WUA for sockeye spawning, but are still less than the flows required to provide maximum WUA for chinook spawning. After October 7, HCP flows are equal to or greater than the level required to provide maximum WUA for chinook spawning.

Fish passage up to Landsburg is assumed to be met when adult chinook have enough depth of water. Although the absolute minimum flow that would allow passage was not determined, the flow study demonstrated that passage of adult chinook would not be impeded at flows of 94 cfs or more as measured at the low flow blockage located 0.5 miles upstream of the confluence with Rock Creek. The HCP flow regime will ensure that normal flows are substantially greater than 94 cfs at this location after September 15.

The HCP flow regime attempts to balance three sometimes competing spawning habitat considerations during the fall: (1) maximizing the quantity (WUA) of available spawning habitat at any given time for chinook and sockeye; (2) further increasing the cumulative amount of sockeye spawning habitat available during the spawning season by gradually increasing flows above the level that provides maximum WUA; and (3) increasing flows above the level required to create maximum WUA for spawning to recruit additional sockeye spawning habitat along the stream margins in an effort to reduce the risk of redd scour during subsequent flood events

Although guaranteed flows are generally higher than the levels that provide maximum WUA for most of the year, in the late summer and early fall they are not. Guaranteed flows in August and the first two weeks of September, the typical period of lowest natural inflow, are slightly below the levels that provide maximum WUA for rearing steelhead and coho. At this time of year, guaranteed flows provide 98 to 99% of maximum WUA for juvenile coho and steelhead rearing. Habitat duration analyses summarized in HCP Appendix 37 demonstrate that, for this period as a whole, expected flows under the HCP regime provide more WUA for juvenile steelhead rearing than expected flows under the existing IRPP regime or expected flows that would occur under natural conditions without the presence of water storage and diversion facilities.

In an effort to provide more edge spawning habitat for sockeye salmon and potentially reduce subsequent sockeye redd scour vulnerability, high normal guaranteed flows may be provided after October 7. High normal flows exceed the levels required to provide maximum WUA for chinook spawning for the duration of the spawning period, but still provide between 95% and

98% of maximum WUA for chinook spawning. Habitat duration analyses summarized in Appendix 37 demonstrate that, for the chinook spawning period as a whole, expected flows under the HCP regime will provide more WUA for chinook spawning than expected flows under either the existing IRPP regime or the natural flow regime.

During the third week in September and first week of October, the HCP minimum flow commitments are equal to the existing minimum flows. During the fourth week of September, HCP flows provide significantly greater WUA for chinook spawning. These increased flows result in a reduction in WUA for sockeye spawning and reduced capacity to provide additional cumulative spawning habitat for sockeye. However, these losses in sockeye spawning habitat are believed to be offset by the benefits provided to chinook salmon that tend to spawn slightly earlier than sockeye.

From October 8 through mid-November the HCP low-normal flows are approximately equal to the flows that provide maximum WUA for chinook spawning. HCP high-normal flows during this period are greater than the flows that provide maximum WUA for chinook spawning. Although the elevated high-normal flows reduce WUA for chinook spawning, these losses are very small (less than 3.5 percent) and are offset by benefits of providing additional incubation protection for all salmon species, increased cumulative sockeye spawning habitat, and increased sockeye spawning habitat along the stream margins where redd scour is believed to be less frequent and less severe.

(2) *Winter Flows.* Chinook spawning is complete by mid-November, but sockeye continue to spawn in the mainstem through the end of December, and coho continue to spawn until mid-February. Sockeye spawning remains the primary focus through December, but salmon incubation protection is also important during this period. By January, protection of incubating salmon becomes the primary consideration for instream flows. Flows remain elevated well above the level that provides maximum WUA for coho spawning and to reduce the risk of redd dewatering. Although the elevated flows reduce WUA for coho spawning, most coho are thought to spawn in tributaries to the mainstem and chinook and sockeye incubation protection is considered a higher priority for mainstem flow considerations.

By early February, substantial numbers of sockeye and chinook fry are emerging and emigrating downstream to Lake Washington. Sockeye fry emergence and migration peaks in late March, continues through mid- to late May, and is the primary concern for instream flows through mid-April. From February 11 through April 14, HCP flows are elevated further to improve conditions for emigrating sockeye and chinook fry. There may be conflicts with favoring hatchery sockeye emigration over allowing naturally spawned chinook fry to emigrate at will. Preliminary fry

trapping information suggests that chinook fry emigration, which are about the same size as sockeye in January and February, may not be influenced by high flows as by other factors (see discussion above in chinook under ENVIRONMENTAL BASELINE).

Steelhead begin to spawn in early March and continue through early June. HCP minimum flow commitments remain well above the levels that provide maximum WUA for steelhead spawning, resulting in a moderate loss of steelhead spawning habitat during this entire period. Although important, WUA for steelhead spawning is considered to be of secondary importance to sockeye outmigration conditions and salmon incubation protection during this period.

(3) *Spring Flows.* After April 14, steelhead spawning flows become increasingly important. Incubating steelhead that are spawned after April 14 will remain in the gravel through the period during which flows begin to drop to summer base flow levels and are therefore more vulnerable to dewatering than the offspring of early spawners. If stream flows remain substantially elevated for extended periods of time after April 14, substantial numbers of steelhead may be forced to spawn in areas that are at substantial risk of being dewatered prior to the completion of fry emergence. Therefore, HCP minimum flow commitments between April 14 and May 12 trend downward. However, to provide continued protection for incubating salmon, HCP minimum flow remain well above the levels required to provide maximum WUA for steelhead spawning.

After May 12, flows are allowed to drop slightly closer to the levels that create maximum WUA for steelhead spawning to coincide with peak steelhead spawning activity in early to mid-May. Water temperatures begin to warm during this time of year and juvenile rearing becomes increasingly important as young steelhead, coho, and chinook enter a period of active feeding and rapid growth. After May 12, flows begin to drop to provide increased WUA for steelhead spawning and juvenile salmonid rearing. However, to protect incubating steelhead, flows remain well above levels that provide maximum WUA for steelhead spawning and rearing.

(4) *Summer Flows.* From early June through early August, steelhead incubation protection is the primary focus of instream flow management. Flows during this period remain well above the level required to provide maximum WUA for juvenile steelhead, coho, and chinook and therefore result in a loss in rearing habitat. However, these habitat losses are quite small and are not believed to pose a threat to the populations. The amount of water available for instream flows from June 17 through August 4 will be determined each year by the CRIFC based upon needs for steelhead incubation protection as demonstrated by in-season redd monitoring studies, water supply conditions, and other factors deemed

appropriate.

After the completion of steelhead incubation in early August and prior to the start of salmon spawning in mid-September, juvenile coho and steelhead rearing are the primary concerns for instream flow management. This is a period of active feeding and growth for juvenile salmonids. Although the flows are slightly lower than the flows required to provide maximum WUA, they are sufficient to provide 98 - 99 percent of maximum WUA for juvenile steelhead and coho rearing.

(5) *Downramping prescriptions.* The City's small hydroelectric facilities at Cedar Falls and water supply facilities at Landsburg operate at relatively constant levels and are not operated in a manner that provides for diel peaking and associated flow oscillations. Therefore, downramping is perhaps less of a concern on the Cedar River than in other regulated rivers with large hydroelectric facilities that vary flows to meet varying electrical demands during the course of a day. Nevertheless, adjustments to the City's water supply and hydroelectric facilities do result in a substantial number of stream flow reductions during the course of a year.

At present, there are no downramping prescriptions on the Cedar River. The HCP provides downramping prescriptions that are patterned after WDFW downramping prescriptions (Hunter 1992, cited in the HCP). Downramping prescriptions will substantially reduce the risks of stranding salmonids and other species of fish throughout the river downstream of the Landsburg Dam beginning in HCP year 1. These protections will be extended to the river above the Landsburg Dam once anadromous fish are allowed to pass upstream. Therefore, PS chinook will have a low likelihood of adverse impacts from down-ramping.

(6) *Relocated and Enhanced Measurement Points.* The stream flow measurement point for the present instream flow regime is located at the existing USGS stream gage #12119000 in Renton, 1.6 miles upstream from Lake Washington. The new configuration of measurement points will provide improved conditions for anadromous fish in several ways. First, measurement at Landsburg provides added protection for the upper portions of the lower river below Landsburg. Under the current measurement regime, actual flows at Landsburg can be varied in a quite unnatural manner to meet target flows 22 miles downstream at Renton. In fact, there are times when releases from Landsburg can approach zero while still meeting current target flows at Renton. By moving the measurement point to Landsburg, the upper reaches of the lower river will be better protected and flows downstream of the diversion dam will vary in a much more natural manner according to changes in natural inflows to the

lower river. Secondly, the establishment of downramping measurement points at Landsburg and Cedar Falls will substantially reduce the risk of stranding juvenile fish during operational reductions in stream flow. And finally, the establishment of a minimum stream flow measurement point upstream of the Cedar Falls powerhouse will provide added protection for the bypass reach and upper portions of middle Cedar River downstream from the powerhouse. Therefore, PS chinook are expected to benefit from a greater assurance of instream flows by relocating the point of flow regulation closer to the point of diversion.

(7) *Funding for Improvements at the Ballard Locks.* All anadromous fish in Lake Washington must pass through the locks twice during their lives. Recent investigations suggest that opportunities may exist to improve the efficiency with which freshwater is used at the locks (ACE 1991, cited in the HCP) and provide better conditions for downstream migrating anadromous fish (Goetz et al. 1997, cited in the HCP). Water flow at the locks must be shared between vessel traffic and upstream and downstream migrating fish. Between June 15 and September 30, the typical dry season, the HCP minimum flow regime ensures that, under minimum flow conditions, substantially more water will flow into Lake Washington than under the existing minimum flow regime.

In addition, the City will help fund measures at the Ballard Locks to improve fish passage conditions and improve water use efficiency in an effort to make even more water available for fish passage. Specific improvements in conservation measures to be implemented at the Ballard Locks are expected to be the subject of a section 7 consultation with the ACOE over the next year or so. These measures are expected to help improve the survival of juvenile anadromous salmonids, including PS chinook, as they emigrate downstream through the facilities to saltwater.

(8) *Conditions in the River Upstream of the Landsburg Dam.* The construction of emergency flow bypass facilities at the City's Hydroelectric Facility will help reduce the risks of fish stranding throughout the Cedar River downstream of Cedar Falls. The construction of a tailrace barrier at the facility will reduce hazards to upstream migrating fish. The provision of flows in the bypass reach upstream of the hydroelectric facility will improve conditions for juvenile salmon rearing and adult spawning.

Flows in the river immediately upstream of the Landsburg Dam will be substantially greater than flows immediately downstream of the dam except during relatively infrequent shut down of the municipal water supply intake. The minimum HCP stream flows coupled with the relocation of the measurement point to Landsburg ensures that flows in the Cedar River upstream of the Landsburg Dam will typically be near or greater than the flows required to provide maximum

WUA for key species and life history stages once anadromous fish are allowed to pass upstream of the Landsburg Dam.

e. Instream Flows Upstream of Landsburg Diversion for Chinook, Coho, Steelhead and Coastal Cutthroat

(1) Landsburg to Lower Cedar Falls. Restoring access for chinook, coho and steelhead into the habitat upstream of the Landsburg Diversion Dam is a central component of the proposed HCP's conservation strategy for anadromous fish. Due to the need to deliver water via this stream reach for diversion into the municipal water supply intake at Landsburg, flows immediately upstream of Landsburg will generally be greater than flows immediately downstream of Landsburg except when the diversion facilities are taken out of service. Interruptions in service at the intake are very infrequent and only occur when raw water turbidity thresholds are exceeded (which typically only occurs during the ascending leg of freshet flows in excess of 1,000 cfs) and during infrequent maintenance and repair activities.

In contrast to the existing flow regimes, the Landsburg compliance point combined with the additional flows required for the City's municipal water supply diversion, ensure that flow levels in the river upstream of the Landsburg Dam and below the Cedar Falls Powerhouse will be near or above the levels required to provide maximum WUA for chinook, coho, and steelhead spawning and rearing at all times. Table 4.4-5 of the Final E.A. provides an example of expected habitat conditions near the center point of the upper Cedar River Study Area (upstream of the Landsburg Diversion Dam) under the proposed HCP normal minimum flow regime.

f. More details in the HCP and Related Documents.

Potential effects of the HCP flow regime upon Cedar River anadromous fish are further described in the Draft E.A., the Final E.A., the Response to Public Comments on the Public Review Draft of the E.A., and are summarized below for each species.

g. Habitat Exceedence Curves Comparing HCP flows to Unregulated and Historic Flows.

A series of comparisons have been supplied to this analyst by the City. Using PHABSIM data for chinook spawning, and steelhead spawning and rearing, the degree to which HCP weekly flows provide WUA are compared with natural (i.e., calculated unregulated) weekly flows, and historic weekly flows over the period of record 1946-1992, for Cedar River study reaches 1, 2, and 3. These three study reaches cover the main sections of river used by spawning anadromous fish (from RM 1.7 to the City water diversion at RM 21.8). In summary, at 50% exceedence, HCP flows provide slightly WUA that either the historic or natural flows for spawning chinook in all three reaches. For spawning steelhead, 50% exceedence flows are essentially the same for HCP and historic flows, and well above natural flows, for all three reaches. Similarly, steelhead rearing WUA, at 50 % exceedence, is essentially the same for HCP and historic flows, and well above natural flows, for study reaches 1 and 2 in late spring. In late summer, HCP flows would be slightly more than either the historic or natural flows.

h. Chinook Salmon

(1) Salmon spawning flows in the fall and winter. In the fall, spawning conditions for salmon become a key biological consideration. The first returning adult chinook salmon begin to enter the river and spawn in early September. Guaranteed flows at this time are also below the level required to provide maximum WUA for chinook spawning. However, by September 15 with approximately 5% of the chinook run typically in the river, guaranteed flows increase to a level that provides 77% of maximum WUA. By September 23, with approximately 16% of the run in the river, guaranteed flows increase to a level that provides 95% of maximum WUA. By October 8, with 50% of the run typically in the river, guaranteed flows increase to a level that is equal to or greater than the level required to provide 100% of maximum WUA. For the rest of the chinook spawning season, low normal flows remain at the level that provides maximum WUA for chinook spawning. In an effort to recruit additional edge habitat for spawning sockeye, high normal HCP flows would slightly exceed existing flows and flows required to provide maximum WUA for chinook spawning. High normal HCP flows remain at this level for the duration of chinook spawning and provide between 89 and 98 percent of maximum WUA. The decrease in potential chinook spawning habitat due to high flows occurs during the latter portion of the run after the majority of the chinook have spawned.

During September and October under the critical flow regime, HCP flows provide 45 to 83 percent of the maximum WUA for chinook. By November 5, HCP flows increase and slightly exceed the existing requirements, thus providing between 93 to 97 percent of the maximum WUA for the remainder of the spawning period.

Therefore, both the normal and critical flow regimes under the IFA are expected to provide sufficient instream flows for spawning PS chinook.

(2) Salmon incubation flows in the winter and spring.

Chinook spawn in the fall and early winter when increased stream flows can occur during storm events typical of the season. During periods of naturally high flows in the fall, chinook may spawn in areas that are at risk of being dewatered if flows subsequently drop to lower levels. To reduce the risk of redd dewatering and mortality of salmon eggs and alevins, HCP minimum flows would remain elevated above the existing to help ensure that nearly all available spawning habitat would remain inundated based on the effective spawning analysis developed by the CRIFC (CES 1991). The Landsburg flow compliance point further reduces the risk of redd dewatering in the river near Landsburg.

The timing and location of chinook spawning make their redds somewhat vulnerable to scour during floods associated with large winter storm events typical of the western Cascade Mountains. To date there are insufficient empirical data to quantitatively determine the risk of chinook redd scour under the IFA. There is no evidence that the IFA would add any additional risks of redd scour during infrequent major floods. Therefore, PS chinook incubation would be likely by adequately met by the IFA.

(3) Chinook rearing and emigration flows in the spring.

Water management decisions on the Cedar River are very complex during the spring. Managers must consider the needs of (1) incubating salmon and steelhead, (2) spawning steelhead, (3) rearing juvenile steelhead, coho and chinook, (4) emigrating sockeye and chinook fry, and (5) emigrating chinook, coho and steelhead smolts in the lower river. In addition to protection of anadromous fish, decision makers must also consider (1) flood management, (2) refilling Chester Morse Lake in a manner that protects nesting loons and incubating bull trout and (3) continuing to provide a safe and reliable municipal water supply.

The factors that may govern juvenile chinook emigration behavior and survival are complex and include discharge, photoperiod, water temperature, turbidity, predator abundance, river system geography, food abundance, fish density, fish size, and swimming ability. The relative importance and interaction of discharge in relation to these other factors that may govern juvenile chinook emigration survival is now unknown but is the subject of proposed supplemental studies (section 4.5.2 of the final HCP), funded by the City and directed, overseen, and interpreted by the CFIFC. But all the available evidence indicates that PS chinook juveniles would be adequately supplied with instream flows by the IFA.

In addition, the relative importance of conditions for chinook emigration versus conditions for chinook instream rearing is unclear but has been proposed as a topic of supplemental studies by the City. Flow levels in the spring and early summer are well above the levels that provide maximum WUA for chinook juvenile rearing. Increased velocity and depth associated with these higher flows may provide benefits for emigrating juvenile chinook. However, the increased velocity and depth also result in an overall reduction in available habitat for rearing juvenile chinook, particularly for those fish of smaller sizes before about April. Reductions in rearing habitat and elevated stream velocities could encourage newly emerged fry to move into the lake environment shortly after emergence when they are very small and have relatively limited swimming ability. The relative benefits of early stream rearing versus lake rearing is unknown for Cedar River chinook and has been proposed as a topic of supplemental studies by the City.

Chinook fry trapping information collected in 1998 and 1999 is summarized above in Section IV. There is no indication that chinook fry emigration in the Cedar River is consistently closely related to periods of increases in flows. Two years of observations found similar patterns: most fry emigrated in approximately mid-February, with a second, smaller peak of much larger fry in late-May to early June. During the early fry emigration, there may be conflicts with favoring sockeye emigration over allowing chinook fry to emigrate at will. Chinook fry emigrations after preferred rearing habitats become filled are not necessarily aided by higher flows, and may instead be timed to new moon periods as noted above in Section IV.

The flows provided by the proposed HCP flows are well above the levels that provide maximum rearing habitat for juvenile chinook salmon during their in-river residence period, as projected by WUA. Because of their complex juvenile life history pattern and the introduction of Lake Washington into their migration pathway, it is not at all clear that elevated spring flows are beneficial for juvenile chinook in the Cedar River. In addition, as many as 10 different salmonid species/life stages may be present in the Cedar River during the period when juvenile chinook are emerging, rearing and emigrating, i.e., mid-January through mid-July. The proposed HCP flows during this period attempt to meet the needs of not only juvenile chinook, but also spawning and incubating steelhead, emigrating sockeye fry, rearing yearling and sub-yearling steelhead and coho. Although elevated flows may be beneficial for some life stages, they can be detrimental to others. For example, an increase in flow from 290 cfs to 950 cfs (as measured at Renton) during the month of May, that may be expected to favor emigration of juvenile chinook, results in a 74% reduction in WUA for steelhead spawning and a 64% reduction in WUA for chinook rearing (CES 1991). In addition, during periods of elevated flows in the spring, increased velocities and depths in much of the channel can encourage steelhead to spawn in many areas where their eggs will be vulnerable to dewatering as stream flows recede to normal summer base levels in July (Burton and Little 1997, cited in the HCP).

Unlike other freshwater life history stages, such as spawning and rearing, there are no indices for evaluating the amount of flow required for successful and timely juvenile chinook emigration. HCP minimum flows during chinook emigration would be greater than the levels that provide maximum WUA for chinook rearing. Minimum flows, as measured at Renton, range from 578 cfs to 345 cfs and average at least 421 cfs from January 21 to June 16. For the years when supplemental flows are provided in the first 6 of the 9 weeks between Feb 11 and April 14, then the average for the entire period January 21 to June 16 would be 452 cfs. Higher flows result in a reduction in juvenile chinook rearing WUA habitat, but may benefit emigrating juvenile chinook. Flow management decisions during much of this period also consider the requirements for steelhead spawning and salmonid egg incubation. Because runoff in the lower 57 percent of the basin is not controlled by the City, heavy precipitation downstream of Chester Morse Lake during this period can occasionally cause high flow events. Such natural events may facilitate chinook emigration and may or may not benefit juvenile chinook survival, depending perhaps on their coincidence with new moons.

Preliminary investigations conducted by WDFW suggest that the juvenile chinook population in the Cedar River displays a variety of early life history patterns (D. Seiler, WDFW, pers. com., 1999). Although chinook typically rear in estuaries for periods of several weeks, in the case of the Cedar River fish, young chinook no longer have ready access to an estuary. Because the Cedar River was rerouted into Lake Washington during the early 1900s, all juvenile chinook from the Cedar River must now swim through approximately 19 miles of slack water that supports a wide variety of native and introduced predators before reaching the marine environment. As they enter the marine environment, juvenile chinook must pass through the Ballard Locks and cope with a highly modified marine/freshwater interface that has relatively little resemblance to a natural estuary. This hydrologic configuration is foreign to native Cedar River chinook that historically migrated only a short distance in the Duwamish River between the Cedar River and the Duwamish Estuary. It is not clear to what degree Cedar River chinook have been able to adapt to this rather dramatic alteration of their environment.

If, for example, juvenile chinook that migrate immediately out of the Cedar River contribute to the majority of the smolt production in the system, then spring juvenile rearing conditions in the river are less of a concern and spring in-river emigration conditions become a greater concern. Alternatively, if young chinook that rear in the river for three months in the Cedar before migrating through the lake survive better than fish that enter the lake as newly emerged fry, then juvenile rearing conditions in the river during the spring are an important consideration.

Much of the Cedar River downstream of the Landsburg Dam is confined by levees. The average width of the active channel is now estimated to be approximately one half the width of the active channel in the mid-1800s prior to the impacts of development (King County 1996). During periods of high stream flow, the availability of suitable fry rearing and refuge habitat in this confined and narrowed channel can be substantially reduced, since little shallow margin habitat is available.

i. Critical Habitat for Chinook

Designated critical habitat for chinook includes riparian and instream conditions supported by the HCP conservation measures, including the proposed flow regime. Based on the preceding analysis of WUA and other flow considerations, it is expected that the HCP conservation measures, including the commitments for fish passage, watershed protection, and instream flows will not adversely modify or destroy critical habitat for PS chinook. In fact, many, if not all, of the constituent elements of critical habitat would be maintained or restored by the conservation measures of the HCP, e.g., riparian shade, sediment routing, inputs of nutrients and all sizes of organic materials, and streambank stability. Natural ecological processes will gradually dominate the riparian and watershed conditions on City lands as trees grow and human influences become reduced by closing and repairing roads. Water quality provided by the City at Landsburg will continue to be high in order to meet water standards for human consumption. Instream flows controlled by the City will likely provide what PS chinook need to immigrate, spawn, incubate, rear, and emigrate.

j. Coho Salmon

(1) Coho spawning flows in the fall and winter. Coho salmon begin to enter the river and spawn in mid-October and continue to spawn into February. Coho spawning is believed to be concentrated in tributaries, but limited spawning may occur in the mainstem. HCP guaranteed normal flows are well above the flows required to provide maximum WUA for coho spawning and higher than the existing IRRP minimum flows throughout the entire coho spawning period. Guaranteed flows during this period provide between 64% and 75% of maximum WUA for coho spawning. Considerations for coho spawning during this period are secondary to considerations for a number of other important biological factors. Elevated guaranteed flows at this time are designed to provide: i) increased WUA for chinook spawning; ii) increased edge habitat for sockeye spawning; iii) improved incubation protection for chinook, coho and sockeye; and iv) improved emigration conditions for sockeye fry. Habitat duration analyses based on expected flows, rather than guaranteed or minimum flows, demonstrate that, for the coho spawning period as a whole, the HCP regime provides more WUA for coho spawning than expected natural flows and about the same amount as provided by expected flows under the IRPP regime (See final HCP Appendix 37).

HCP minimum normal flows throughout the entire coho spawning remain well above flows required to maximize available coho spawning habitat within the mainstem channel of the Cedar River. Since the preferred spawning habitats for Cedar coho are in small tributaries, the degree to which Cedar WUA may affect coho spawning success is assumed to be minor. Flows as measured at Landsburg are more than double than those required to maximize WUA during the peak of the coho spawning activity during the month of January. The IFIM study suggested that nearly 30 percent of the potentially available spawning habitat in the mainstem would be lost with HCP normal minimum flows in January. During the early spawning period of October through December, low normal flows provide 68 to 92 percent of maximum WUA; high normal flows provide 60 to 92 percent of maximum WUA. By the end of the spawning period in mid February, normal minimum flows provide only 52 percent of the maximum WUA in the Cedar mainstem. HCP critical flows also exceed the level required to provide maximum WUA for coho spawning from mid-October through February, but provide 93 to nearly 100 percent of maximum WUA through the period. The IFA was developed based on the CRIFC consideration that the benefits for enhanced sockeye and chinook spawning, incubation, and emigration flows outweighed the potential risk to mainstem coho spawning habitat. This assessment included an understanding that coho prefer spawning in small tributaries.

(2) Coho rearing flows year-round. Compared to other life history stages, WUA for juvenile rearing is less sensitive to flow in the Cedar River (CES 1991). The flows that create maximum WUA for juvenile steelhead rearing are greater than analogous flows for juvenile coho. Therefore, the CRIFC selected juvenile steelhead as the primary target for rearing flow considerations. For most of the year, from mid-September through early August, the proposed HCP normal flow prescriptions are well above levels required to provide maximum WUA for juvenile steelhead and also coho rearing. Although flows at times are two to three times greater than the levels that provide maximum WUA, the loss in rearing habitat is relatively small. During August and the first two weeks in September, proposed HCP normal flows drop to levels that approach the existing minimum flow levels. During this period, both regimes provide 98 to 99 percent of maximum WUA for steelhead rearing. Under the HCP critical flow regimes, flows remain below optimum levels from mid June through early October, but still provide between 95 to 99 percent of the available habitat.

k. Steelhead Trout

(1) Steelhead spawning in the spring. Steelhead begin to enter the river and spawn in early March and continue to spawn into early June. HCP guaranteed normal flows are well above the flows required to provide maximum WUA for steelhead throughout their entire spawning period and greater than IRPP flows for most of the period. Guaranteed flows during this period provide between 75% and 98% of maximum WUA for steelhead spawning. Elevated flows during the steelhead spawning season can encourage steelhead to spawn in less suitable areas that are more vulnerable to dewatering during the later portion of the incubation period as stream flows drop to normal base flow conditions. This concern is heightened during the later portion of the steelhead spawning period. After mid-May, HCP flows drop slightly below IRPP minimum flows but remain above the levels that provide maximum WUA. This drop in flows substantially increases WUA for spawning steelhead and provides the opportunity to reduce the risk of subsequent redd dewatering for the most vulnerable portion of the population. Habitat duration analyses based on expected flows, rather than guaranteed or minimum flows, demonstrate that, for the steelhead spawning period as a whole, expected flows under the HCP regime provide more WUA for steelhead spawning than expected flows under natural flow conditions or expected flows under the IRPP regime (see final HCP Appendix 37).

Concerns for steelhead spawning during this time are balanced with efforts to maintain higher flows to protect incubating salmon, improve conditions for emigrating sockeye fry and provide beneficial conditions for rearing chinook and coho. The generally elevated levels in guaranteed flows during this period result in a reduction in WUA for rearing chinook and coho salmon.

Flows during this period provide gradually increasing levels of WUA for juvenile coho and chinook rearing that range from 58% of maximum WUA at the start of the period to 78% of maximum at the end of the period.

After May 12, flows are allowed to drop slightly closer to the levels that create maximum WUA for steelhead spawning to coincide with peak steelhead spawning activity in early to mid-May. Water temperatures begin to warm during this time of year and juvenile rearing becomes increasingly important as young steelhead, coho, and chinook enter a period of active feeding and rapid growth. After May 12, flows begin to drop to provide increased WUA for steelhead spawning and juvenile salmonid rearing. However, to protect incubating steelhead, flows remain well above levels that provide maximum WUA for steelhead spawning and rearing.

From mid-June through the end of July, incubating steelhead become a primary concern for instream flow management. As mentioned previously, steelhead redds can be vulnerable to dewatering when stream flows drop to normal summer base levels. The flexible HCP guaranteed flow regime, coupled with a real-time steelhead redd monitoring program provide key information and management flexibility that will allow full protection of all steelhead redds in most years. Flows during this period will generally be greater than existing IRPP minimum flows but typically less than expected natural flows. HCP guaranteed flows are generally well above the levels that provide maximum WUA for coho, chinook, and steelhead rearing during this period. Flows during this period provide between 76% and 84% of maximum rearing WUA for these three species. The amount of water available for instream flows from June 17 through August 4 will be determined each year by the CRIFC based upon needs for steelhead incubation protection as demonstrated by in-season redd monitoring studies, water supply conditions, and other factors deemed appropriate.

(2) *Steelhead rearing flows year round.* Compared to other life history stages, WUA for juvenile rearing is less sensitive to flow in the Cedar River (CES 1991). The flows that create maximum WUA for juvenile steelhead rearing are greater than analogous flows for juvenile coho. Therefore, the CRIFC selected juvenile steelhead as the primary target for rearing flow considerations. For most of the year, from mid-September through early August, the proposed HCP normal flow prescriptions are well above levels required to provide maximum WUA for juvenile steelhead rearing. Although flows at times are two to three times greater than the levels that provide maximum WUA, the loss in rearing habitat is relatively small. During August and the first two weeks in September, proposed HCP normal flows drop to levels that approach the existing minimum flow levels. During this period, both existing and HCP regimes provide 98 to 99 percent of maximum WUA for steelhead rearing. Under the HCP critical flow regimes, flows remain below optimum levels from mid June through

early October, but still provide between 95 to 99 percent of the available habitat.

1. Coastal Cutthroat Trout.

The IFIM study did not specifically address cutthroat. The relatively small size, occurrence mainly in tributary and headwater streams, and overlap in spawning times with winter and spring high flows are all factors that suggest this species is unlikely to be flow-limited in the Cedar River.

The instream flow regime under the HCP will protect any coastal cutthroat trout in the mainstem Cedar River by providing assurances that flows throughout the majority of the reach between Lake Washington and Lower Cedar Falls would be equal to or greater than the levels provided by the existing IRPP recommended flows for most of the year (HCP Section 4.4.2). Insofar as any coastal cutthroat trout may spawn in the mainstem Cedar River, the elements of the instream flow regime designed to protect the redds of salmon and steelhead that spawn in shallower areas near the river margin from dewatering will also afford protection to any coastal cutthroat trout redds that may occur in these mainstem areas, particularly because coastal cutthroat trout spawn timing broadly overlaps with the spawning period for steelhead (Wydoski and Whitney 1979, cited in the HCP). Continuation of the steelhead redd monitoring program under the HCP will provide information that can be used to establish flow regimes that protect incubating steelhead, as done currently, and would be expected to offer similar protection to anadromous (and resident) cutthroat trout.

In addition, as part of the proposed instream flow management regime, the compliance point of stream flow will be moved approximately 20 miles upstream near the Landsburg Diversion Dam.

Because of this change, flows will remain higher downstream of Landsburg as a result of the groundwater and surface water inputs that occur downstream of the measurement point. The change in the location of the measurement point will also allow flows to fluctuate in a more natural manner in the lower river.

The City is anticipating no alterations in its flood management practices as a result of the HCP. Consequently, the City anticipates little or no change in the magnitude, frequency, duration, or timing of peak flow events. Channel forming processes associated with these peak flows serve to maintain habitat that could be used by coastal cutthroat trout, although most adults and juveniles would more likely use smaller tributaries that are still vulnerable to land management activities. Rapid downramping of stream flows in the mainstem of the Cedar River as a result of City water supply and hydroelectric operations could strand coastal cutthroat trout fry or juveniles in

shallow areas, particularly along stream margins, potentially resulting in death of some individuals from high temperature or dehydration, to the extent that the small fish could not reenter flowing water. The HCP will moderate the rate at which instantaneous stream flow could be reduced by the operations of the City's water supply and storage facilities. This moderation should substantially decrease the risk of stranding coastal cutthroat trout as compared to the risk under current operations. A recent analysis of the frequency and magnitude of instream flow changes on the Cedar River suggests that significant downramping events can occur quite frequently during normal operations. Under the existing IRPP flow regime, no formal downramping criteria are used to guide flow control operations.

m. Sockeye Salmon

(1) Sockeye spawning flows in the fall. Instream flows under the HCP are designed to improve sockeye spawning conditions throughout the fall. The first adult sockeye begin to enter river and spawn in early to mid-September. During the first two weeks of September, HCP flows are slightly below the level that provides maximum WUA. At this time, HCP flows provide 99% of maximum WUA. By September 16, with approximately 11% of the sockeye run typically in the river, HCP flows increase to a level that is slightly above the level required to provide maximum WUA for sockeye spawning. Although this results in a slight reduction in WUA, HCP flows during the third week in September still provide more than 98% of maximum WUA. By the last week of September, with approximately 20% of the run in the river, HCP flows increase to a level that provides 85% of maximum WUA. On October 8, with approximately 38% of the sockeye run in the river, flows increase further to either low normal or high normal levels, depending on existing hydrologic conditions in the basin. In an effort to maximize WUA for spawning chinook and provide potential ancillary benefits to spawning sockeye, both low normal and high normal flows remain well above the levels required to provide maximum WUA throughout the remainder of the sockeye spawning season. From October 8 through December 30, low normal HCP flows provide between 56% and 71 % of maximum WUA for sockeye spawning. High normal flows provide between 51% and 61% of maximum WUA during this same period.

Although significant amounts of potential sockeye spawning habitat are lost at these higher flows, these potential losses are partially offset by increases in potential cumulative sockeye spawning habitat. Flow increases that begin in late September will tend to encourage newly entering fish to spawn in previously unsuitable habitat away from areas that are already seeded. This stepped approach to flow regulation also accommodates the theory that edge spawning habitat is less vulnerable to damaging scour during subsequent peak flow events.

(2) Sockeye incubation flows in the winter and spring.

During September HCP flows provide approximately 97 percent of maximum WUA for sockeye spawning. Critical flows begin to increase on October 1 and exceed the level required to provide maximum WUA for sockeye spawning by the second week of October. With a smaller overall increase in flows during this period, critical flows provide less cumulative gains in sockeye spawning habitat and less edge habitat for sockeye spawning.

(3) Salmon incubation flows in the winter and spring.

Sockeye spawn in the fall and early winter when increased stream flows can occur during storm events typical of the season. During periods of naturally high flows in the fall, sockeye may spawn in areas that are at risk of being dewatered if flows subsequently drop to lower levels. To reduce the risk of redd dewatering and mortality of salmon eggs and alevins, HCP minimum flows remain elevated above the existing flows to help ensure that nearly all available spawning habitat would remain inundated based on the effective spawning analysis developed by the CRIFC (CES 1991). The Landsburg flow compliance point further reduces the risk of redd dewatering in the river near Landsburg. Unlike the existing regime, HCP flow releases at Landsburg must remain elevated throughout the incubation period. This is especially valuable to sockeye salmon incubation, as the Astep® approach to flow regulation may encourage spawning activity along channel margins that are more vulnerable to dewatering.

The timing and location of sockeye spawning make their redds vulnerable to scour during floods associated with large winter storm events typical of the western Cascade Mountains. Sockeye spawning habitat nearer the stream margins is believed to be somewhat less vulnerable to scour during flood events (Ames and Beecher 1995). To date there is insufficient empirical information to quantitatively determine the risk of sockeye redd scour. The CRIFC found results of the risk zone analysis inconclusive for the purposes of quantitatively defining risk zones and safe zones. However, the results did indicate trends and phenomena that may be useful in understanding bed scour and its potential impact on sockeye redds in the Cedar River. These indications are that: scour of sockeye redds may be initiated at between 1,800 and 2,000 cfs; short term high river flows can substantially reduce egg to fry survival; and safe and risk zones are not clearly delineated in terms of channel margin and mid-channel zones. For instance, a number of mid-channel redds incurred minimal scour at even the highest flood flows. Further analysis of the redd scour data by the CRIFC indicated a slight reduction in sockeye redd scour in spawning habitat near the edges of the stream. The HCP flow regime accommodates the notion that, provided the opportunity, sockeye will spawn in zones of less risk to scour near the stream margins. The HCP high normal flow curve provides more edge habitat than existing throughout the sockeye spawning period. The HCP low normal curve provides more edge habitat after mid-November.

The spawn timing of sockeye salmon make their redds especially vulnerable to fluctuating stream flows associated with late fall and early winter freshets. Under the current IRPP flow regime

with the measurement point in Renton, sockeye eggs deposited near the margins of the stream are at risk of desiccation during periods when local inflows are elevated in the lower river. With a measurement point 20 miles downstream at Renton, the City can substantially reduce releases at Landsburg and still meet IRPP flow targets during periods of normal to high inflows in the lower river. Therefore, any redds established near the margins of the stream in the upper portions of the river near Landsburg are subject to a significant risk of dewatering and eventual egg desiccation. By relocating the flow measurement 20 miles upstream at Landsburg, the HCP substantially reduces this risk and helps promote more natural variations in stream flow throughout the lower river.

To further reduce the risk of redd dewatering throughout the river, the HCP guaranteed flows remain elevated during the winter and early spring to reduce the risk of redd dewatering. HCP guaranteed flows remain well above existing flow IRPP targets throughout the entire winter and spring sockeye incubation season.

(4) Sockeye emigration flows in the spring. Elevated flows for incubation protection during the winter and spring also provide benefit for emigrating sockeye. There is assurance that flows will remain elevated throughout the river, as the Landsburg compliance point requires sustained flow releases throughout the emigration period. Although the exact quantitative relationship between stream flow and the survival of emigrating wild sockeye fry is not presently known, HCP flows contain provisions for 40 percent higher minimum flows at least 70 percent of the time during the peak of sockeye emigration from early February through mid-April. These elevated flows can be in direct conflict with optimum habitat conditions for the early portions of the steelhead spawning period.

Recent information suggests that newly emerged hatchery sockeye fry can experience significant mortality during their 1- to 2-day migration downstream to Lake Washington. Preliminary investigations with hatchery fry releases just above the present upstream limit of sockeye migration and spawning suggest that fry may experience significantly higher emigration survival during periods of elevated flow (Seiler 1994, 1995; Seiler and Kishimoto 1996, 1997a; all cited in the EA).

Although the instream flow regime is designed to improve spawning conditions for sockeye salmon as well as reduce the likelihood of mortality of incubating eggs and alevins during winter flood events, some level of redd scour and related mortality during incubation are normal parts of salmon life history. Because of the constrained nature of the lower Cedar River and the fact that the upper reservoir and Masonry Dam have limited storage capacity and only capture runoff from the uppermost 43 percent of the basin, water management under the HCP will not eliminate all redd scour resulting from flood flows. Variability in sockeye incubation survival in the river can be substantial, varying with the magnitude of peak flows during incubation. Any such death,

direct injury, or disturbance is largely the result of natural hydrologic events. The actions of the HCP do not exacerbate these natural effects. To the contrary, the proposed artificial production program and downstream habitat protection and restoration commitments provide the potential to substantially off-set the damaging effects of natural peak flow events on incubating sockeye in the mainstem of the river.

C. Determination of Post Termination Mitigation

As described above in sections 6.3 and 6.4 of the IA, the Services will, in the event of suspension or revocation, review all relevant data to determine whether take of the covered species occurring prior to the date of suspension or revocation has been substantially mitigated in accordance with the permit conditions. If the Services demonstrate that take of such species that occurred during the term of the permit has not been substantially mitigated, they may require continuation of specified HCP activities until such time as mitigation is substantially completed. Substantial mitigation will have occurred if the mitigation that has been provided under the HCP at least compensates for the take that has occurred under the permit as of that date. At this time, NMFS can preliminarily determine that certain HCP conservation measures described below would be the substantially completed mitigation necessary for satisfying provisions 6.3 and 6.4 of the Implementing Agreement. Other sources of substantial mitigation that may not need to be continued to mitigate for possible "take" of covered anadromous fish cannot be described at this time and may be of a nature that would require the City to continue actions to avoid or minimize "take."

Road improvement included in the HCP (section 4.2) is focused on reducing sediment loading to streams and improving fish passage at road crossings. Benefits to aquatic species will increase over time with completion of specific road improvement projects through reduction of sediment loading levels to more natural levels and consequent improvement of aquatic habitat. To achieve a level of mitigation under the HCP that would not require any post-termination mitigation, the City will complete five years of the road improvement program specified in Section 4.2 of the HCP.

Road decommissioning included in the HCP is focused on reducing sediment loading to streams, improving fish passage at road crossings (by removal of roads), and reducing the road network to those roads needed for municipal watershed management under a program of no timber harvest for commercial purposes. Benefits to aquatic species will increase over time with decommissioning of specific road segments with potential to deliver sediment to streams through reduction of sediment loading levels to more natural levels and consequent improvement of aquatic habitat. To achieve a level of mitigation under the HCP that would not require any post-termination mitigation, the City will decommission 20 miles of roads under the program specified in Section 4.2 of the HCP, with a priority on removal of road segments with high

potential for sediment delivery to streams. This projection of 20 miles is based on the Cedar River Watershed Assessment, Mass Wasting and Surface Erosion Assessment, Section 3.2.5 (City 1995).

Construction of the fish screens and fish ladders, proposed for HCP year 3, would, when shown to be successfully operating for a period of at least 2 years, substantially remove the potential "take" associated with the current lack of fish passage at Landsburg and the nearby pipeline. By making the water diversion structures at Landsburg and the pipeline essentially neutral to up- and down-stream passage of anadromous fish (except for introduced sockeye salmon), any ESA "take" of ESA listed fish associated with those City facilities would be negligible.

D. Indirect And Cumulative Effects

1. Indirect Effects.

Indirect effects are those that are caused by the action and are later in time but still relatively certain to occur (50 C.F.R. ' 402.02). The action in this context is the issuing of an ITP and unlisted species agreement for anadromous salmonids, under section 10(a)(2)(B) of the ESA. When and if any of the four currently unlisted species of anadromous salmonids are listed for federal protection, then those species would be added to the ITP. This plan is for 50 years so most effects analyzed are considered as direct effects of the action. Therefore there are no discernable indirect effects of the Watershed Management that can be analyzed at this time.

2. Indirect Effects of Anadromous Fish Mitigation.

Beneficial indirect effects of restored anadromous fish passage include increased nutrients (i.e., phosphorous) from decaying fish carcasses in autumn and winter. There are also a number of potential adverse indirect effects of the sockeye production program described in the HCP and in Appendix 29 that will be considered by the CRAFC and the HCP Oversight Committee as the decision is made how to proceed with that program. Specific potential effects to the species of fish are discussed above under section VI (B). Indirect effects of the sockeye production program to PS chinook, coho, and steelhead are considered minor. Generally, the risks to sockeye populations increase with greater reliance on hatchery production, while wetland and floodplain disruption would increase as the emphasis shifts to sockeye production from habitat projects in the lower Cedar River or elsewhere in the Lake Washington basin. Any collaborative decision of the specific mix of hatchery and habitat elements of the sockeye production program will involve NMFS, as a member of the three HCP implementation committees, and will ensure that listed fish are not jeopardized or critical habitat adversely modified or destroyed. A NEPA analysis will be conducted for the collaborative decision whether to proceed with the replacement sockeye

hatchery (section D of the LMA).

3. Indirect Effects of Cedar Instream Flows

Indirect effects of the instream flows downstream of City lands may include effects to the channel and floodplain from peak flows, or altered routing of organic materials and sediment as natural routing of those materials may be interrupted at the Landsburg Diversion Dam. The total effect of these potential effects to anadromous fish and their habitats is likely minor and is described in section 4.2.3 of the final EA (City et al., 1999a).

Indirect effects of the IFA may be evident within the Cedar River mainstem channel and some associated side-channels, but not any tributaries, in which the flows could be influenced by the IFA. It is difficult to describe any indirect effects of the IFA that could act upon one of the five anadromous fish species and that extend beyond the mouth of the Cedar River and that can be analyzed at this time.

The Cedar River comprises an important component of the total annual inflow to Lake Washington. However, the City does not direct the allocation of the lake's outflow to the various requirements for navigation, saltwater management and fish passage at the Ballard Locks which comprise the outlet to Lake Washington. Over the 50-year term of the HCP, actual daily flows in the Cedar River will range well above the minimum HCP instream flows much of the time. The HCP expected instream flows are assumed to have the same average annual diversion for the next 50 years (118 million gallons per day- mgd) as was observed over the past 50 years (within the range of 85 to 144 mgd). Expected HCP flows assure at least as much water reaching the lake throughout the year as the current flow regime, for which there is no evidence of effects upon lake levels. Wide variations of streamflows under existing conditions would continue under the proposed HCP flow regime. During the summer/fall drawdown period, the proposed HCP flow regime provides slightly more water near the mouth of the Cedar River than either the existing flow regime or the historical actual gauged flows. But the HCP and existing flow regimes provide essentially the same amount and timing of instream flows for the winter flood and spring refill periods.

Natural variability in unregulated inflows will continue to be evident within the 18.8 miles of Cedar River below the new compliance point for HCP flows at River Mile 20.4. This natural variability is expected to mask any potential indirect effects of the HCP flow regime downstream from the lower Cedar River. An estimated 33 % of the Cedar River basin is downstream of City lands at River Mile 20.8. In addition, some 19 miles of lake between the mouth of the Cedar River and the locks will separate potential effects of Cedar River flows from the locks by that intervening distance.

The U.S. Army Corps of Engineers (ACOE) operates the Ballard Locks, regulates the levels of

Lake Washington and Lake Union, and estimates that Cedar River flows contribute about half of their operational flows. But their operations for fish passage and ship lockage are essentially independent of the IFA since lockage (governed by the Rivers and Harbors Act) and fish passage must be provided regardless of the City's commitments to provide Cedar River flows. Potential indirect effects of Cedar River instream flows upon lake levels are difficult to define since the ACOE selects a management target for regulating lake levels based on the goal of minimizing conflicts to shoreline residents and commerce. Current management of lake levels by ACOE, during the spring time that PS chinook juveniles may rear along the shoreline, entails starting to refill Lake Washington on February 15, with a target date of reaching elevation 20.0 feet by May 1. The ACOE now has flexibility to manage the lake levels, and the proposed HCP flow regime would give greater assurance of flows. The ACOE expects to begin section 7 consultations with NMFS on improvements to operations of the Ballard Locks within the next year. The current operational policy by the ACOE to "maintain the lake level at or above 20.0 feet in 7 out of 10 years" could be instead be replaced by a lower lake level that would further mask any potential effects of Cedar River instream flows upon lake levels or at the locks.

4. Cumulative effects

Are those effects caused by other projects and activities unrelated to the action under consideration. Since the City owns virtually all of the Cedar River watershed upstream from Landsburg (about 69% of the total watershed area), there is no potential for cumulative watershed effects from the combined management of City lands and other ownerships within the upper Cedar watershed. There are no potential downstream effects of water supply operations outside City lands, aside from the potential effects of instream flows described above as indirect effects, since those ongoing operations would not be changed due to issuance of an ITP. One other potential cumulative effect is associated with anadromous salmonid fishery management. Changes in populations of some species may occur as HCP conservation measures contribute to increased fish production. This potential effect will be addressed by the existing institutional framework of fishery management, facilitated by the framework of the CRAFC.

There are potential cumulative effects to instream and floodplain conditions in the lower Cedar River, downstream from City lands, from a variety of land management actions under the control of King County and WDFW through their respective permitting authorities. NMFS is not aware of any planned and permitted state or private actions that would be individually or cumulatively adverse to salmonid habitats in the lower Cedar River. A recent watershed plan by King County (1996) and a draft recovery plan for the Lake WA chinook (MIT et al. 1999) identified a number of potential actions along the Cedar River valley, but there are none described as reasonably certain to occur in the action area. Ongoing actions by the Federal Emergency Management Agency (FEMA) to remove residential structures from the floodplain are expected to improve local floodplain function.

The conservation measures identified in this HCP minimize the impacts of instream flows, restored anadromous fish passage, sockeye production, watershed management, monitoring and research, and mitigate for impacts to anadromous salmonid species that may be affected by those activities. Therefore possible cumulative adverse effects to PS chinook and other anadromous salmonids will likely be decreased by implementing this HCP, and habitat for sensitive life stages of anadromous salmonids will be either maintained, enhanced, or protected.

Future increases in water withdrawals by the City and other water users may result in seasonally altered instream conditions. Proposed studies by the City are intended to collect sufficient information to better understand indirect flow effects and thereby enable the Instream Flow Oversight Commission to arrange to minimize and avoid adverse effects of altered flows.

E. Summary and Synthesis of Effects of the HCP, IFA, and LMA

- Watershed management on City lands may result in slight to negligible, transient, and local adverse effects from operations that disturb the ground or vegetation within riparian areas.
- Many, if not all, of the constituent elements of critical habitat for PS chinook would be maintained or restored by the conservation measures of the HCP, e.g., riparian shade, sediment routing, inputs of nutrients and all sizes of organic materials, and streambank stability.
- Natural ecological processes will gradually dominate the riparian and watershed conditions on City lands as trees grow and human influences become reduced by closing and repairing roads. Water quality provided by the City at Landsburg will continue to be high in order to meet water standards for human consumption.
- PS chinook and other anadromous fish species that currently spawn and rear in the 21.8 miles of mainstem river habitat downstream of the Landsburg diversion dam can be expected to recolonize the habitat above Landsburg, so restored fish access would be an overall beneficial effect.
- Based on analyses of weighted usable area, and other Cedar-specific considerations, instream flows controlled by the City will likely provide what PS chinook and other anadromous fish species need to fulfill all their life requisites, i.e., immigrate, spawn, incubate, rear, and emigrate.
- The potential for indirect and cumulative adverse effects to PS chinook and other anadromous salmonids will likely be decreased over time by implementing this HCP, and habitat for sensitive life stages of anadromous salmonids will be either maintained, enhanced, or protected.

F. Conclusions

To make the determination that the proposed action will not jeopardize the continued existence of listed or proposed species, or adversely modify or destroy designated critical habitat, NMFS must consider the status of the species under the environmental baseline, and any associated direct, indirect or cumulative effects. A similar approach has been taken for anadromous salmonids addressed in this HCP as part of the Unlisted Species Analysis. This is necessary as the City requests assurances (i.e. No Surprises) that they will receive a Section 10(a)(1)(B) incidental take permit for threatened PS chinook and currently unlisted anadromous salmonids that are adequately addressed in the HCP, when and if they are listed under the ESA.

Considering the species' current status, the existing environmental baseline, and the expected effects of the HCP (including the IFA and LMA), there are likely to be effects of the proposed action that are largely beneficial to all five species of fish, including PS chinook.

Although incidental take would be authorized under the Section 10(a)(1)(B) permit, the extent of take is not expected to appreciably reduce the likelihood of survival and recovery of PS chinook or result in destruction or adverse modification of critical habitat. As well, the extent of take is not expected to appreciably reduce the likelihood of survival and recovery of PS coho, PS steelhead, coastal cutthroat, or sockeye salmon. Implementing the HCP and associated IFA and LMA will likely contribute to conservation of threatened PS chinook and the four other species of anadromous salmon and trout that are not ESA listed: PS coho, PS steelhead trout, coastal cutthroat trout, and sockeye salmon.

VII. INCIDENTAL TAKE STATEMENT

Section 9 of the ESA and Federal regulations pursuant to section 4(d) of the ESA prohibit the take of endangered and threatened species, respectively, without special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct. Harm is further defined to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the proposed action is not considered to be prohibited taking under the ESA provided that such taking is in compliance with this Incidental Take Statement.

Take of PS chinook has not yet been prohibited by a final rule, although a rule is proposed at this

time (65 FR 170). NMFS expects that prohibitions against take for PS chinook will be in effect within several months from the date of the proposed rule.

The proposed Cedar River HCP and its associated documents identify anticipated impacts to species of anadromous fish likely to result from the proposed taking and the measures that are necessary and appropriate to minimize those impacts. Once the new fish screens and ladders are functioning near the Landsburg diversion dam, projected by HCP year 4, the extent of incidental take resulting from covered activities will markedly decrease. Other ongoing covered activities with a likelihood of causing injury or death to individual anadromous salmonids include water supply operations, sediments introduced to streams from watershed management, and hydro-electric generating facilities. For example, screens that separate fish and floating organic materials from water intakes could be means of "take," depending on the water velocities. Fish could be stranded as water is drawn-down too quickly. Downstream incubating eggs could be smothered or scoured by careless operations at the Landsburg diversion dam. Fish could be dewatered or smothered in tributary streams next to forest road repair or near-stream water supply maintenance. The frequency, location and duration of covered activities resulting in levels of impacts severe enough to harm fish is too speculative to allow NMFS to estimate possible numbers of fish taken under this HCP. All conservation measures described in the proposed HCP, together with the terms of the associated Implementing Agreement and the section 10(a)(1)(B) permit or permits issued with respect to the proposed HCP, are hereby incorporated by reference as reasonable and prudent measures and terms and conditions within this Incidental Take Statement pursuant to 50 CFR 402.14(I). Such terms and conditions are non-discretionary and must be undertaken for the exemptions under section 10(a)(1)(B) and section 7(o)(2) of the ESA to apply. If the permittee fails to adhere to these terms and conditions, the protective coverage of the section 10(a)(1)(B) permit and section 7(o)(2) may lapse. The amount or extent of incidental take anticipated under the proposed Cedar River HCP, associated reporting requirements, and provisions for disposition of dead or injured animals are as described in the HCP and its accompanying section 10(a)(1)(B) permit.

NMFS particularly wants to emphasize the following term and conditions:

- The schedule in sections 4.3.2 and 5.3 of the final HCP now states that completion of construction will occur by the end of HCP year three for fish ladders, downstream passage improvements, and screens on the water intake at Landsburg.
- The final HCP specifies that a comprehensive public involvement and environmental review process in year three of the HCP will be required for final approval of construction of the replacement sockeye hatchery, specifying that the decision will include the final design and capacity of the hatchery, and its operating guidelines.
- The final HCP (Section 4.3) and the Landsburg Mitigation Agreement clarify that the hatchery decision in HCP year three is contingent on approval by the signatory parties (i.e.,

the City, NMFS, USFWS, and WDFW) of the hatchery design, capacity, operating guidelines, and adaptive management program.

A. Puget Sound Chinook - Listed Species

The NMFS anticipates that an undetermined number of PS chinook salmon may be taken as a result of full implementation of the proposed action and associated level of protection over the 50-yr life of the permit. The incidental take of this species is expected to be in the form of harm, harassment, kill and injury, resulting from covered activities under the HCP.

By far the greatest extent of take of PS chinook could occur from the continued blocked fish migration at the pipeline and the Landsburg diversion dam. As noted above, once the adult fish ladders and juvenile fish screens are constructed and become functional (projected by HCP year 4), then the overall extent of take of PS chinook would drastically decrease. There may be take of juvenile salmonids associated with construction of those facilities from introduced sediments, altered flows, or temporary reductions in water quality. Instream work will be timed for summer low flow periods to avoid impacts to spawners and incubating eggs.

Certain HCP-covered activities occur year-round (e.g., instream flows and water supply operations), while near-stream facility repair and reconstruction typically occur during low water periods in late summer. The extent of take of PS chinook can be described by area of the Cedar River, season, and life-stage. Incubating fish within redds could be harmed in the mainstem spawning areas, during September through mid-May, in areas located below the diversion dam until the fish ladders are operational, and then in the entire Cedar River from the mouth upstream to the natural anadromous fish barrier at lower Cedar Falls. Juvenile and developing fish (e.g., alevins, parr, and smolts) could be harmed throughout the available rearing habitats within and adjacent to the Cedar River and accessible tributaries and side-channels from about January through early summer. Migrating and holding adult fish could be harmed throughout the accessible river at times during their spawning migration from about early September through mid-December.

As analyzed previously in this opinion, the NMFS has determined that this level of anticipated take is not likely to result in jeopardy to the species or destruction or adverse modification of critical habitat.

Harm may occur due to habitat modifications resulting from watershed management, road management, the provision of instream flows, and other water supply operations.

Harassment may occur due to instream activities where fish are present, such as

construction and operation of the fish ladders and screens, road maintenance and improvements, and monitoring activities.

Kill may occur due to the use of equipment in streams during construction and maintenance activities associated with the watershed roads and water supply operations

Injury may occur due to instream activities where fish are present, such as construction and operation of the fish ladders and screens, road maintenance and improvements, the provision of instream flows, and monitoring activities.

B. Coho Salmon - Unlisted Species

The NMFS anticipates that an undetermined number coho salmon may be taken as a result of full implementation of the proposed action and associated level of protection over the 50-yr life of the permit. The incidental take of this species is expected to be in the form of harm, harassment, kill and injury, resulting from covered activities under the HCP.

Harm may occur due to habitat modifications resulting from watershed management, road management, the provision of instream flows, and other water supply operations.

Harassment may occur due to instream activities where fish are present, such as construction and operation of the fish ladders and screens, road maintenance and improvements, and monitoring activities.

Kill may occur due to the use of equipment in streams during construction and maintenance activities associated with the watershed roads and water supply operations.

Injury may occur due to instream activities where fish are present, such as construction and operation of the fish ladders and screens, road maintenance and improvements, the provision of instream flows, and monitoring activities.

C. Steelhead - Unlisted Species

The NMFS anticipates that an undetermined number of steelhead may be taken as a result of full implementation of the proposed action and associated level of protection over the 50-yr life of the permit. The incidental take of this species is expected to be in the form of harm, harassment, kill and injury, resulting from covered activities under the HCP.

Harm may occur due to habitat modifications resulting from watershed management, road management, the provision of instream flows, and other water supply operations.

Harassment may occur due to instream activities where fish are present, such as

construction and operation of the fish ladders and screens, road maintenance and improvements, and monitoring activities.

Kill may occur due to the use of equipment in streams during construction and maintenance activities associated with the watershed roads and water supply operations.

Injury may occur due to instream activities where fish are present, such as construction and operation of the fish ladders and screens, road maintenance and improvements, the provision of instream flows, and monitoring activities.

D. Cutthroat - Unlisted Species

The NMFS anticipates that an undetermined number of cutthroat trout may be taken as a result of full implementation of the proposed action and associated level of protection over the 50-yr life of the permit. The incidental take of this species is expected to be in the form of harm, harassment, kill and injury, resulting from covered activities under the HCP.

Harm may occur due to habitat modifications resulting from watershed management, road management, the provision of instream flows, and other water supply operations.

Harassment may occur due to instream activities where fish are present, such as construction and operation of the fish ladders and screens, road maintenance and improvements, and monitoring activities.

Kill may occur due to the use of equipment in streams during construction and maintenance activities associated with the watershed roads and water supply operations.

Injury may occur due to instream activities where fish are present, such as construction and operation of the fish ladders and screens, road maintenance and improvements, the provision of instream flows, and monitoring activities.

E Sockeye (& Kokanee) Salmon - Unlisted Species

The NMFS anticipates that an undetermined number of sockeye or kokanee salmon may be taken as a result of full implementation of the proposed action and associated level of protection over the 50-yr life of the permit. The incidental take of this species is expected to be in the form of harm, harassment, kill and injury, resulting from covered activities under the HCP.

Harm may occur due to habitat modifications resulting from watershed management, road management, the provision of instream flows, and other water supply operations.

Harassment may occur due to instream activities where fish are present, such as

construction and operation of the fish ladders and screens, road maintenance and improvements, and monitoring activities.

Kill may occur due to the use of equipment in streams during construction and maintenance activities associated with the watershed roads and water supply operations.

Injury may occur due to instream activities where fish are present, such as construction and operation of the fish ladders and screens, road maintenance and improvements, the provision of instream flows, and monitoring activities.

VIII. REINITIATION OF CONSULTATION

Based on the information in the City's HCP, the NMFS anticipates a limited and small extent of incidental take could occur as a result of the action covered by this consultation report. To ensure protection for a species assigned an unquantifiable level of take, reinitiation of this consultation is required: (1) if any action is modified in a way that causes an adverse effect on the species that is new or significantly different from those analyzed in connection with the original HCP; (2) new information or project monitoring reveals adverse effects of the action in a way not previously considered or that involves additional take not analyzed in connection with the original HCP; or (3) a new species is listed or critical habitat is designated that may be affected by the action (50 C.F.R. 402.16).

In the event that after permit issuance, unforeseen circumstances arise or new information becomes available, and such circumstances or information lead NMFS to believe that the effects of the permittee's activities on a covered species will be sufficiently more severe than originally analyzed under the section 7 intra-service consultation performed at the time of permit issuance, such that a covered species could be jeopardized by the covered activities, NMFS shall proceed as follows. First, it shall utilize its resources to conserve the species. Second, it shall work with the permittee to voluntarily reduce the effects of covered activities on the species. Third, NMFS shall reinitiate section 7 consultation on the permit and shall document its analysis of the new effects in a biological opinion. Conservation efforts undertaken by NMFS or the permittee shall be considered in the analysis, as well as any information provided by the permittee regarding the probability of jeopardy. If reinitiation of consultation results in a finding that covered activities are likely to jeopardize the species, then NMFS will (i) consult with the permittee to identify a reasonable and prudent alternative (RPA) and modify the HCP accordingly; or (ii) remove that species from the ITP, after which any prohibitions against take would apply.

There is a concern for a substantial increase in City water diversions, before the supplemental studies of potential effects of instream flows upon PS chinook are completed and interpreted, within the first 10 years of the IFA. Therefore, if the City annual average water diversions exceed 118 mgd in any of the first 10 years after issuance of the ITP, then NMFS will reinitiate

consultation of this Biological Opinion to determine the potential for jeopardy to PS chinook or any other ESA-listed anadromous fish species. That determination will consider any evidence that adverse effects of the instream flow regime to listed fish are greater than analyzed herein. Since the IFA schedule is from September 2 through the following September 1, and collection of necessary information will require several months, the earliest that reinitiation could occur is within six months after the conclusion of the first complete water year of City operations. In subsequent years, reinitiation could begin within six months after the conclusion of any water year ending September 1.

IX. SECTION 10 (a)(2)(B) FINDINGS

A. Permit Issuance Considerations

Although only one of the five anadromous salmonids addressed in the HCP is listed under the ESA at this time, this document is intended to provide the City assurances that they will receive an Incidental Take Permit if and when such unlisted species are subsequently listed under the ESA, subject to the "unforeseen circumstances" clause in the IA. In order to issue an incidental take permit under 50 C.F.R. ' 222.22(c)(1) the NMFS must consider the following:

1. The status of the affected species or stocks.

The status of anadromous salmonids potentially affected by the HCP has been considered above (see Section III of the Biological Opinion). The environmental baseline for anadromous fish and their habitats (Section IV) was also considered.

2. The potential severity of direct, indirect and cumulative impacts on anadromous salmonids and their habitats as a result of the proposed activity.

The impacts of the HCP were examined in detail in this analysis (see Section VI of the Biological Opinion).

3. The availability of effective monitoring techniques.

Monitoring of the implementation of the HCP and the effectiveness of the HCP prescriptions are a critical feature of this HCP. Monitoring reports will be completed and submitted to the NMFS and the USFWS according to the schedule described in section 4.5 of the HCP. Note that the frequency and period of monitoring varies by plan element with compliance monitoring of key items extending throughout the entire 50-year plan term.

4. The use of the best available technology for minimizing or mitigating impacts.

The prescriptions established in this HCP represent the most recent developments in science and technology in minimizing and mitigating impacts to riparian and aquatic habitats, from road management to construction of fish ladders and a sockeye production program. Further, the

adaptive management component of this HCP assures new science and technology will continue to be employed in the HCP as it is developed.

5. The views of the public, scientists and other interested parties knowledgeable of the species or stocks or other matters related to the application.

Over the past few years, the City has hosted many tours of the watershed, meetings with stakeholders, and kept concerned citizens informed with periodic mailings (documented in the Response to Public Comments to the final EA, May 1999). In order to get scientific involvement in development of the HCP, the City held workshops on specific issues, including bull trout and conservation biology, and co-sponsored other workshops on ecological studies of Lake Washington.

Public comments were solicited on the completed permit application package and availability of an Environmental Assessment by announcement in the Federal Register (63 FR 68469, and 64 FR 480) (USDI 1998, and USDC 1999). The comment period ended March 1, 1999, and during that time 280 letters and e-mails were received that included about 1,100 detailed comments, and 78 people presented comments at two public hearings. All of the oral and written comments, together with responses to those comments prepared by the NMFS, FWS, and City, are compiled in a 767 page Response to Public Comments (City et al., 1999b).

Another factor the Services considered in making the decision was consistency with the Federal Trust responsibility to Native American Tribes. This Trust responsibility imposes a duty on Federal agencies to protect Trust assets for Tribes. For the reasons discussed in the Final NEPA EA (including the 160 pages of responses to comments submitted by the Muckleshoot Indian Tribe), the Services have concluded that the proposed HCP modification is consistent with this Trust responsibility.

Beginning early in project development in 1994, the Services worked side by side with the Muckleshoot Tribe as technical issues were discussed and negotiated with the City. Although the Tribe chose to withdraw from multi-party negotiations in early 1997, the City and Services have each continued to meet with tribal policy and technical representatives from time to time. Letters to clarify issues have also been exchanged between NMFS and the Tribe. NMFS engaged the Muckleshoot Tribe in government to government meetings about the City's proposed HCP on several occasions, including July 17, 1998; June 10, 1999; October 22, 1999, and November 10, 1999. The City gave the Tribe early opportunities to review the draft HCP for an additional 78 days in October, November, and December, 1998, before the draft HCP was released to the public December 1998. A draft Biological Opinion was given by NMFS to the Tribe on November 3, 1999, and tribal comments were discussed with technical staff of NMFS and the tribe on November 19 and 24, 1999. The City has offered the Muckleshoot Tribe full

membership on the three, multi-agency HCP implementation committees, and the NMFS will continue to consult with the Muckleshoot Tribe regarding ongoing HCP implementation.

B. Permit Issuance Findings

Having considered the above, the NMFS makes the following findings with regard to the adequacy of the HCP meeting the statutory and regulatory requirements for an Incidental Take Permit under Section 10(a)(2)(B) of the ESA and 50 C.F.R. ' 222.22(c)(2):

1. The taking of listed species will be incidental. The NMFS anticipates that the proposed action would likely result in incidental take of threatened Puget Sound chinook, and other currently unlisted species of anadromous salmonids, if they were listed. Activities that will occur in the HCP area that may result in take may include "harm" through adverse changes in essential habitat features such as blocked access for migrating salmon at the Landsburg Diversion Dam, and additional sediment inputs due to landslides and road use throughout the planning area. Also, take may occur via the "harass, kill, or injury" definition as well, by frightening or disturbing spawning fish during road crossings or monitoring and research activities. Some instances of incidental take will likely occur despite the conservation measures in the HCP. These types of take are speculative, not quantifiable, and would be limited in extent to a fraction of the action area. However, the likelihood of discovering instances of incidental take or enumerating the extent of the incidental take is small.

2. The City of Seattle, acting through the Seattle Public Utility will, to the maximum extent practicable, monitor, minimize and mitigate the impacts of taking anadromous salmonids associated with watershed management and related activities. Measures in this HCP minimize and mitigate for any take impacts that may occur, through assurance of providing fish passage at the current man-made barriers; assurance of instream flows tailored to essential life stages for the five species of anadromous fish; and by the retention of forests throughout the HCP area that assure attainment of properly functioning riparian habitats for fish-bearing streams during the plan term. Also, the City will monitor and conduct research to test assumptions and to determine effectiveness of HCP prescriptions.

The HCP and IA provide specific conservation measures to monitor, minimize, and mitigate the impact of take of PS chinook under the permit.

One measure of "the maximum practicable extent" is to look at how the IFA and HCP fit into the contribution of Cedar River water to the City's entire water supply system. The total claim by the City is 300 million gallons per day (MGD) and the average total river flow is 550 MGD. As described fully in General Comment #50 (City et al, 1999a), the Cedar annual diversions have

ranged between 85 and 144 MGD, averaging about 118 MGD for the last 50 years. The City expects that annual diversions over the 50-year term of the HCP will continue to vary within a wide range and will average approximately 118 MGD over the long run. This range of diversions from the Cedar could be expected to remain when system-wide demand grows, by about 2020, to 171 MGD, if the supply system remains in its current configuration. If other water sources become available by then, the contribution of Cedar water would be expected to decrease. At this average level of diversion, the average annual amount of water left in the river will be about 432 MGD.

Another way to express “the maximum practicable extent” examines how well the IFA compares to instream flow management on a nearby river. Although the City owns about 69% of the total watershed areas of the Cedar River, only 43% of the watershed drains into the reservoirs' catchment area. The total average discharge of the Cedar River at Landsburg is 255,000 acre-ft/yr; and near the mouth of the Cedar River at Renton, 478,200; compared to the annual average flows from the nearby water-supply Howard Hansen Reservoir operated by the City of Tacoma, 719,400 acre-feet on the Green River. The lesser amount of annual flow and storage capacity in the Cedar River system allows for less flexibility in providing instream flows than is offered by the City of Tacoma on their draft HCP for the Howard Hansen Reservoir. Therefore, entities that look to the specific Green River instream flows as a benchmark of what is the "maximum extent practicable" would instead need to look into the details of the Cedar River Instream Flow Agreement (IFA). As revised by the Seattle City Council in July and December of 1999, the IFA includes additional provisions to conduct studies of potential affects on chinook fry; increase the representation of resource managers, including the Muckleshoot Tribe, on the Instream Flow Oversight Committee; and reserve a major portion of the currently unallocated part of the City water claim for fish.

One related concern expressed in public comments was the sufficiency of NEPA alternatives for Instream Flows, and why other alternatives were not fully analyzed. According to analyses by the City, no other flow alternative met their purpose and need, and was therefore not practicable. The five instream flow management alternatives considered but eliminated from further analysis in the Final NEPA documents encompass all substantial aspects of the proposals evaluated, but eliminated during the interagency discussions from 1993 to 1997. These proposals did not meet stated objectives during these discussions and do not meet the stated objectives of the HCP. The proposed HCP instream flow alternative was designed to represent the best achievable scientifically based balance of competing considerations for the various life stages and biological needs of the four target anadromous fish species, while still meeting the objectives of the proposed action, including protection of firm yield and preservation of necessary operational flexibility.

Another measure of “the maximum practicable extent” looks at the sufficiency of the HCP for ESA listed species and their requisite habitats. As described above, and in the parallel Biological Opinion by FWS (FWS 2000), the proposed action of issuing ITPs would have a high likelihood of providing for the survival and recovery of all ESA listed species.

3. Based upon the best available scientific information, the taking will not appreciably reduce the likelihood of the survival and recovery of the species in the wild, or adversely modify or destroy critical habitat for Puget Sound chinook. Conservation measures identified in the plan will increase the quality and quantity of spawning and rearing habitat and result in a benefit to anadromous salmonid species.

The Act's legislative history establishes the intent of Congress that this issuance criteria be based on a finding of "not likely to jeopardize" under section 7(a)(2) [see 50 C.F.R. ' 402.02]. This is the identical standard to Section 10(a)(2)(B). The conclusions regarding jeopardy for the listed ESU and for all other unlisted anadromous salmonid are found in Section VI. D.

CONCLUSIONS, in the Biological Opinion above. In summary, the NMFS has considered the status of the species, the environmental baseline and the effects of the proposed action, and any indirect and cumulative effects, to conclude that issuance of the Incidental Take Permit for Puget Sound chinook and unlisted species agreement to the City for anadromous fish species, would likely not jeopardize the continued existence of any of the anadromous salmonids addressed in the HCP.

4. The plan has been revised to assure that other measures, as required by the NMFS has been met.

The HCP and IA, together with the related Instream Flow Agreement and Landsburg Mitigation Agreement, incorporate all elements determined by the NMFS to be necessary for approval of the HCP and issuance of the permit.

5. The NMFS has received the necessary assurance that the plan will be funded and implemented.

Signing of the IA by the City assures that the HCP will be implemented. Also, the HCP and IA commit the City to adequately fund implementation of the HCP.

C. Conclusion

Based on these findings, it is determined that the City's HCP meets the statutory and regulatory requirements for an Incidental Take Permit under Section 10(a)(2)(B) of the ESA and 50 C.F.R. ' 222.307.

X. PROCEDURES IN THE EVENT OF LISTINGS

As specified in the IA, should any of the currently unlisted plan species subsequently become listed, the City may propose to add that species to the permit. If such an amendment request is received, the NMFS will determine whether such addition would meet the permit issuance criteria under ESA Section 10(a)(2)(B). If the species to be added is already addressed in the HCP, the NMFS will consider, in making the required determinations, the extent to which the City's implementation of the HCP, or any other voluntary conservation measures undertaken by the City since issuance of the permit, have already minimized or mitigated for negative effects on the species. It is expected that, upon listing of a currently unlisted species, additional information will be available in any proposed, final, or emergency listing to determine the habitat and life-history requirements of the species, the range-wide status, threats to the species, applicable management recommendations, and other basic information necessary to complete the amendment processes. Before such species would be added to the permit, the NMFS must find that adding the species to the permit would not appreciably reduce the likelihood of survival and recovery of the affected species in the wild and would be consistent with its other responsibilities.

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